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SCIENTIFIC AMERICAN

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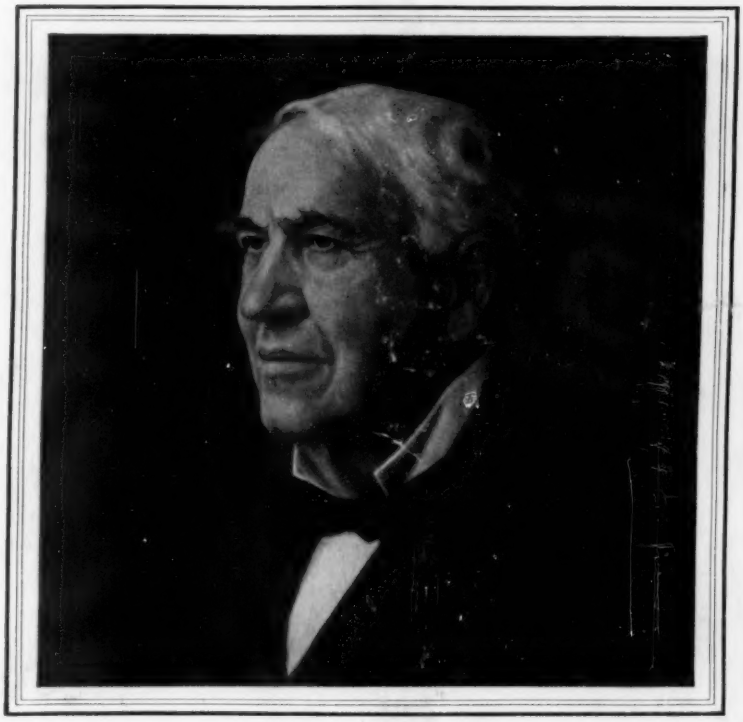


THOMAS ALVA EDISON

SUPER-GUNS FOR OUR ARMY

BY J. BERNARD WALKER

SEEING THE EARTH TURN

SUNBURN IN THE DARK

LINDBERGH

WENT ACROSS ON SKF BEARINGS

There are no service stations along the airways that follow the great waterways. Bearings *must* be dependable.

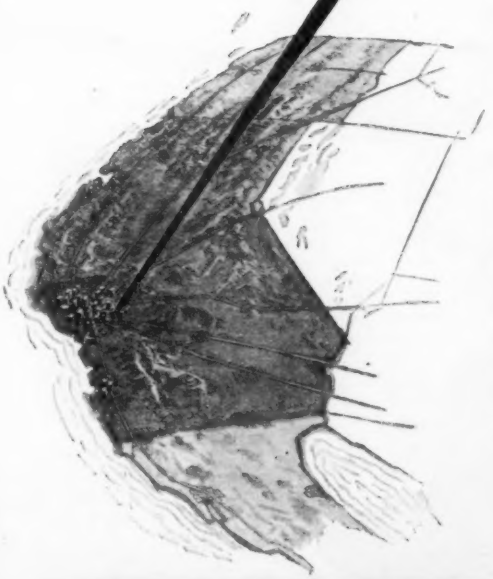
The same bearings were used by Byrd when he flew over the North Pole—by Chamberlin and Acosta on their fifty-hour, record-breaking endurance flight—they were on the NC-4 on its epoch-making trans-Atlantic hop—they were with Lt. Maughan on the famous dawn-to-dusk flight—they are now on the Los Angeles.

1843 **SKF** INDUSTRIES, Inc. 40 East 34th Street New York City

40% of the population of the Pacific Coast States, lives in Southern California

Los Angeles County

is the hub of this Enormous Market



THIS great market, consuming large volumes of manufactured products, has caused many nationally known industries to establish factories here, the latest being the B. F. Goodrich Rubber Co., with a $4,000,000 plant.

These companies have found not only a rich nearby market, but a vast tributary market reached quickly and more economically than from any Western point of distribution, as well as harbor and steamship facilities reaching all world-ports.

Los Angeles County has been truly called "the land of balanced prosperity." A rich market, almost every known variety of raw material, industrial freedom, ample transportation of every kind, low power rates, natural gas and plentiful water and a mild all-year climate—the essential requisites for manufacturing success are here.

Specific information regarding manufacturing opportunities and distribution advantages will be furnished by the Industrial Department, Los Angeles Chamber of Commerce.

INDUSTRIAL LOS ANGELES

The Los Angeles District has over 2,250,000 Population with an Industrial Output Exceeding $1,250,000,000

Scientific American, July, 1927. Vol. 137, No. 1. Entered at the New York, N. Y., Post Office as Second Class Matter June 28th, 1879, under the Act of March 3rd, 1879; additional entry at Dunellen, N. J. Published Monthly by Scientific American Publishing Co., 24 West 40th Street, New York City. Copyright 1927 by Scientific American Publishing Co. Great Britain Rights Reserved. Subscription Price $4.00 per year

Sinews of Steel for Your Car

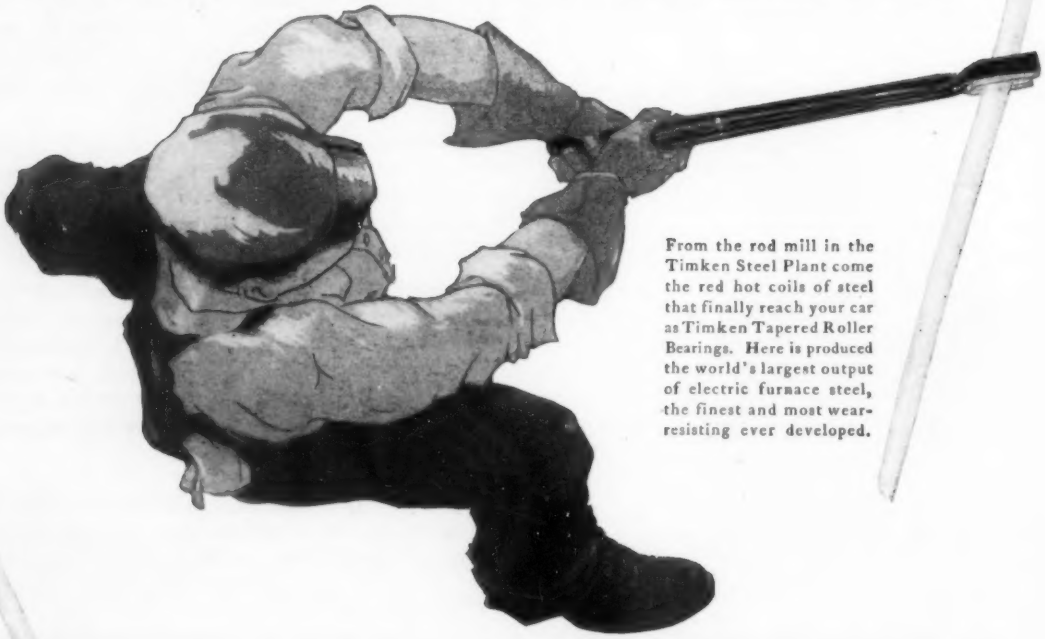
Economy, smoothness, quiet, safety, simplicity and endless endurance—these advantages in your car or truck are best assured by Timken Tapered Roller Bearings in the transmission, differential, pinion or worm drive, rear wheels, front wheels, steering pivots and fan.

Timken electric steel, Timken tapered construction and Timken *POSITIVELY ALIGNED ROLLS* are fully effective against friction *and* side-thrust *and* speed *and* torque *and* weight.

Surely that is what you want. Then make sure you get Timken Bearings, built into a great majority of all makes of motor vehicles, and into every type of industrial equipment.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

TIMKEN *Tapered Roller* **BEARINGS**



From the rod mill in the Timken Steel Plant come the red hot coils of steel that finally reach your car as Timken Tapered Roller Bearings. Here is produced the world's largest output of electric furnace steel, the finest and most wear-resisting ever developed.

SCIENTIFIC AMERICAN

July 1927 *Edited by* ORSON D. MUNN Eighty-third Year

FLIP-FLOPS

WELL—here it is: the new SCIENTIFIC AMERICAN; how do you like it?

We have decreased somewhat in overall acreage, but we are a little bulkier to make up for it—more magazine, as a matter of fact, and in a little different shape.

We wonder whether you realize how much of a job it has been to get ready this new format? We shan't go into all the nightmare of details here—it would require a whole article in itself; yes, more than that—but you may take it on faith that there is much more to it than meets the eye. Planning, planning, wrestling with styles and sizes of type, layout, makeup. Our layout editor has been doing flip-flops over it ever since January.

Now that it is all finished we are going to sit back and await the reaction. If you are satisfied with our efforts, we are more than repaid.

As we said at the beginning, how do you like it?

EDISON

THE impossibilities of yesterday are the commonplaces of today. Our lives are brighter, happier, longer, more effective than those of our fathers. The swift-moving era in which we live is the most wonderful the world has ever known. In the last fifty years greater progress has been made than in all the five thousand years of recorded history which went before. Here is the golden age of invention, and so it will be written in the annals of time.

In the career of one man we find the genius of the age expressed. The story of his life—from boyhood poverty to affluence and veneration in his declining years—epitomizes the opportunities which lie in our democracy. The story of his achievements—including more than a thousand patented inventions—is the very flower of our civilization.

The world is a better place because the wizard of electricity has lived and worked. We feel honored that so great an American has loaned us his portrait that we might reproduce it this month on our cover.

ERROR

IN the May SCIENTIFIC AMERICAN the frontispiece was a picture of Professor R. W. Wood of John Hopkins University, noted physicist. Under this picture we stated that Professor Wood's book, "Physical Optics," was out of print. We have since found out that our informant was wrong—the book is still in print and is published by the Macmillan Company, New York. We are glad to know that "Physical Optics" is still available, because we like it best of all the books on that subject, and recommend it to those who wish to dig into optics.

CONTENTS

JULY 1927

DEPARTMENTS

PLATINUM

ON page 52 we publish the first installment of an article about the famous Meteor Crater in Arizona. Meteor Crater resembles two things: an ordinary volcanic crater and an enormous shell-hole. Some say it *is* a volcanic crater, especially since there are evidences of extinct volcanoes in Arizona. Others claim it is actually a giant shell-hole made by an iron meteor which struck the earth and buried itself deep in the rock.

Meteor Crater is not news—articles about it have appeared in Sunday newspaper supplements for years. Writers have embroidered the description with wild conjecture. The article we now publish is the only first-hand description which has ever been published. It was written by the son of the owner of the Crater. The author is a mining engineer now employed as geologist for a mining company whose name is a by-word the world over. What he says may cause you to revise some of the impressions created by previous erroneous statements about Meteor Crater.

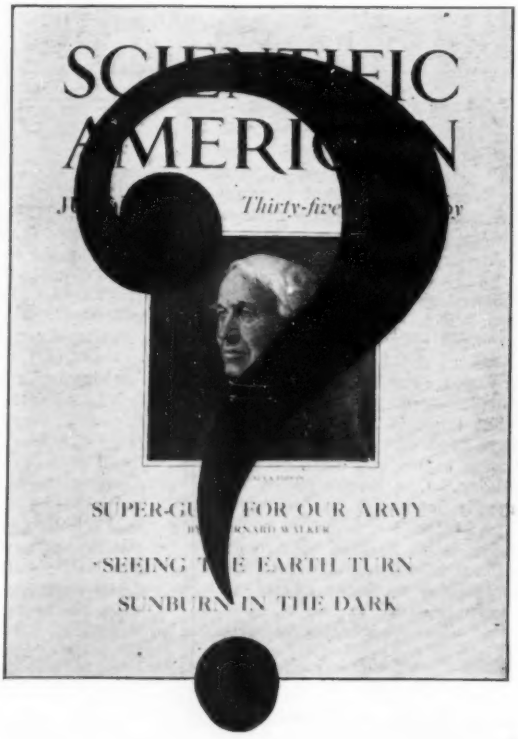
Scientists estimate that the meteor contains 10,000,000 tons of nickeliferous iron in lump form. If the belief that this iron will average four tenths of an ounce of platinum metals per ton turns out to be true, then Meteor Crater is something worth thinking about.

Within a short time a shaft will be sunk near the point beneath which the great meteor is believed to lie. We are holding our breath!

LINDBERGH

THE brevity of this reference to Lindbergh's superb, one-man flight from New York to Paris is due to the fact that we were just going to press when the flight ended. We would have liked to give several pages to a description of the plane, the engine, and the man. Audacity, courage, and skill such as his have ever made a supreme appeal; but when to these is added a natural modesty, it is easy to understand the world-wide applause which acclaimed this gallant youngster. It was sheer audacity to set out with little knowledge of navigation, but the elements were kind, and in less than 34 hours, Lindbergh crossed the Atlantic.

What's the Verdict?



YOU are now looking at the new style Scientific American. If you haven't gone through it already, look through it now and then come back to this page.

How does it appeal to you? Could you locate it more readily on the news stand? Isn't it easier to hold and to handle than the older large size? Don't you find the type easier on the eyes? Doesn't the page size seem to lend itself better to a more pleasing arrangement of reading matter and pictures?

Altogether, don't you agree that it is a superior magazine—one you would be proud to have your friends see on your library table?

As for its contents, you know the Scientific American's position in science and industry. There is no change in the editorial treatment, as you can see from this number you now have in your hands. The editors do strive constantly, however, for improvement, and the material in hand now indicates that every month the Scientific American will be more valuable and interesting than the month before.

If you like this first number of the new style Scientific American, you'll like next month's better, and the month after that better still. Better send in your subscription today—you won't want to risk not getting the magazine every month from now on.

Credit Coupon Good for One Dollar

Scientific American,
24 West 40th Street,
New York City, N. Y.

Send me Scientific American for one year. Check for $3 is enclosed.

Name.....

Street and No.....

P. O.....State.....

This coupon must be used before August 1, 1927.

Here's an added reason for acting now. We're offering you a dollar reduction. Use this coupon before August 1st, and you get a $4 full year's subscription for only $3.

Clip the coupon now while the new style Scientific American is in your hands.

Among our Contributors

DR. D. T. MacDOUGAL

Dr. MacDougal, well-known botanist and author, is director of the two plant-physiology laboratories of the Carnegie Institution of Washington, one in California, the other at Tucson, Arizona. Between these two he makes frequent trips in a steam-driven automobile. He is a member of the famed National Academy of Sciences and is influential in scientific circles. For several years he has been corresponding editor of the SCIENTIFIC AMERICAN. His most recent work bears on the unsolved problem of the nature of life.

DR. ALFRED V. KIDDER

Dr. Kidder has spent virtually his whole life on the archeology of the Southwest, making explorations and excavations. He has been curator of North American Archeology at the well-known Peabody Museum of Harvard University. For several years he conducted excavations at Pecos, New Mexico, for Phillips Academy, Andover. At present he is excavating under the aegis of the National Research Council.

Russell W. Porter

SCIENTIFIC AMERICAN readers know him for his contributions on amateur telescope making. Originally an architect trained at Boston "Tech," he spent twelve years with Peary and others in the Arctic. Co-inventor of the screw-thread comparator, in spare time he is an artist, composer and corresponding editor of the SCIENTIFIC AMERICAN.

Prof. P. W. Bridgman

Professor Bridgman belongs to the Department of Physics at Harvard. One of our editors recently visited him and found him in working clothes in the cellar of the physics laboratory, trying to find a way to exert still higher pressures than those which will stagger the readers of the article commencing on page 43.

Orrin E. Dunlap, Jr.

Mr. Dunlap is our radio editor. Since 1922 he has also been radio editor of the *New York Times*. A member of the Institute of Radio Engineers, he was formerly a Marconi and United States Naval operator. He is a graduate of Colgate University.

D. Moreau Barringer, Jr.

Mr. Barringer is assistant geologist for a famous copper mining company. His father, D. M. Barringer, is the owner of Meteor Crater, Arizona, and has collaborated with his son in the preparation of the engrossing series of articles which begins with this issue, commencing on page 52.

Looking Ahead

with the Editor

TORNADOES

The fact is, little has yet been discovered about the cause of tornadoes. Next month Dr. W. J. Humphreys, foremost Weather Bureau authority on the physics of the air, will present his theory.

TACT

What *is* "social intelligence?" Briefly, it helps you to get along with other people. It makes "college graduates" of unschooled politicians in the race for preferment. Prof. F. A. Moss, psychologist, has tested the social intelligence of 7000 persons. His article about these tests contains surprises. Next month.

TELEPATHY

Spring this question in any group—you have an argument on your hands at once. It is a subject everybody is interested in. In an early issue Dr. Walter Franklin Prince, famous investigator of psychic phenomena, will provide some "meat" for these heated oral battles.

ATHLETICS

With college men in science and college men in athletics it is odd how little the one has been applied to the other. Next month, however, a famous physiologist who also enjoys sports will describe some of these applications. He finds that a runner is virtually a machine.

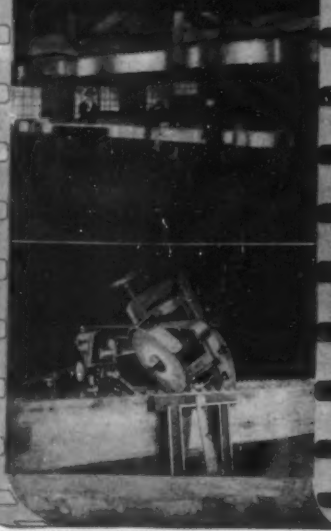
GOLF

Golf clubs designed by following mechanical engineering principles offer the player an opportunity to improve his game vastly. A well-known scientist will tell of his dissatisfaction with existing clubs and how he designed an entirely new type.

'LUMBER'
Another Presentation on GRINDING
by
NORTON COMPANY
WORCESTER, MASS

Axes that fell the trees in the vast forests are shaped and sharpened on grinding wheels in tremendous quantity production.

Saws that work lumber into usable forms are kept sharp by saw-gumming machines equipped with wheels made especially for this purpose.



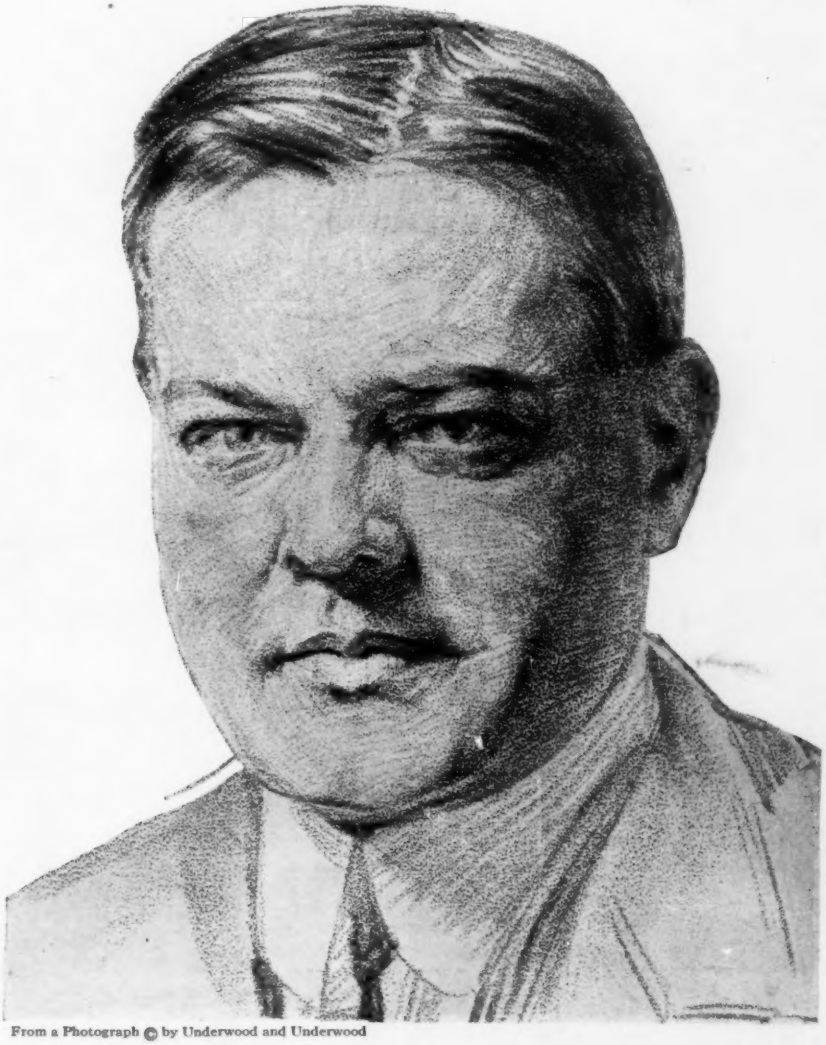
The mechanical Yarder is a typical example of a labor-saving machine of tremendous strength that Man's ingenuity has devised for the lumber industry. Machining operations by the grinding wheel and grinding machine are important steps in the manufacture of this wonderful lumbering apparatus.

Powerful engines of transportation—the caterpillar crawler, the motor truck and locomotive that transport lumber thru the forests owe a share of their efficiency to the production of hundreds of close fitting and working parts by grinding.

NORTON

Grinding Wheels
Grinding Machines

Refractories-Floor
and Stair Tiles



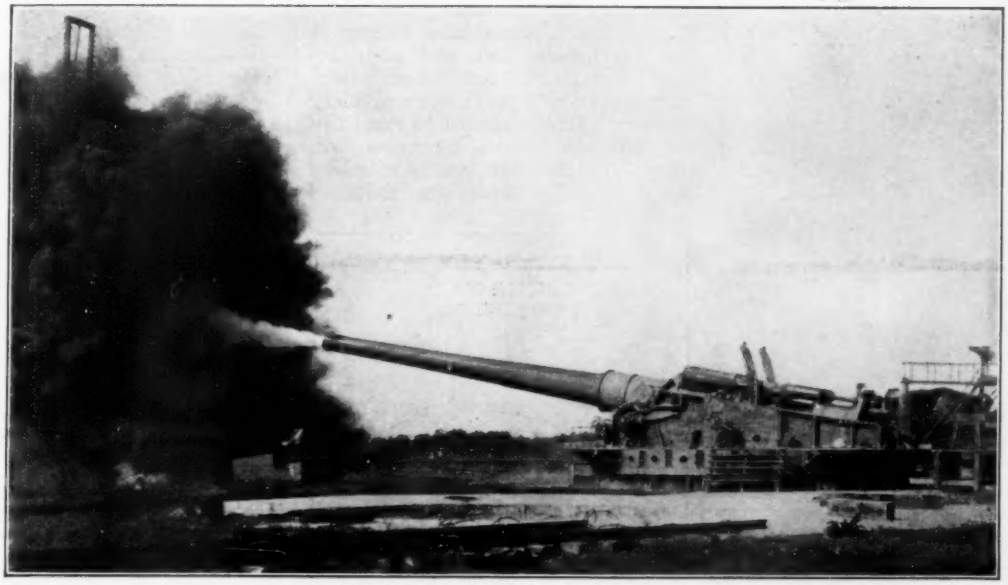
From a Photograph © by Underwood and Underwood

The industrial life of America and the health and well-being of our people are clearly dependent on future applications, by engineers and physicians, of new discoveries in the physical and biological sciences. If we are to go on increasing our population we must either advance in scientific discovery or we must recede in our standard of living. Of even greater importance, however, is the advance of human thought, the stimulation to the human mind which comes from the advance of science, and publications such as the SCIENTIFIC AMERICAN *which pass on to the thinking public the truths our intellectual leaders have uncovered, are rendering a public service whose value cannot be over-estimated.*

Herbert Hoover

Multiple Mount of Four .50-Caliber Machine Guns

The Bureau of Ordnance, under General Williams and his brilliant staff, has spent the post-war years in developing new ordnance material (guns, mounts, fire-control, motorized tractor mounts, aircraft bombs, et cetera,) that shows an average increase in efficiency of one hundred percent or more over the ordnance with which we entered the war. Indeed, the .50-caliber machine gun, shown in the above illustration, is four times as effective as the old .30-caliber machine gun.



ARMY COAST-DEFENSE 16-INCH GUN

Super-Guns For Our Army

Ordnance Officer, Chemist and Mathematician Combined Have Doubled the Efficiency of Our Army Ordnance Since the War

By J. BERNARD WALKER

ONE of the most important, if not indeed the leading factor in the defences of the United States, is the large and highly efficient Proving Ground at Aberdeen, Maryland, which has to do with the development of new and improved types of ordnance and acts as the great testing plant in which the guns that are issued for service are thoroughly tried out. "Its responsibility to the War Department is to design, develop, procure (which includes both purchase and manufacture), test for acceptance, store and issue, maintain and repair, both in the hands of troops and in storage, all army ordnance. Also, it is charged with the training of our Reserve Ordnance Officers."

BEFORE our entrance into the World War, and indeed until January, 1918, most of this work was done at the Sandy Hook Proving Ground. The war had not progressed very far, however, before it was realized that the facilities at Sandy Hook would be inadequate and that a much greater area of land and a larger plant would be necessary to keep pace with the huge ordnance manufacturing program which was contemplated.

So the present site at Aberdeen, Maryland, which is about midway between Baltimore and Philadelphia, was selected. It is accessible to the principal industrial centers; weather conditions are favorable throughout the year, and it was possible to take up an area of adequate size, and sufficiently remote from surrounding communities to let the work of testing go on without danger. The Proving Ground is on the northwest shore of Chesapeake Bay. It covers about 35,000 acres; its maximum width is some four miles and its maximum length 15 miles. The work of testing commenced in January, 1918, and it expanded so rapidly that, just before the Armistice, as high as 70,000 rounds per month were being fired on the grounds.

The main firing platform has an unobstructed range of as high as 30,000 yards. The railway and sea-coast artillery firing ground is so located that there is a clear range up to 30,000 yards in front of it, and a water range down an adjacent stretch of the Chesapeake extending 60,000 yards. The fall of the shell on these water ranges is observed from 12 range towers, built at intervals along the shore of Chesapeake Bay. Intersecting sights taken from these towers of the splash of the falling projectile give its exact position and enable the range to be accurately determined. The Proving Ground plant also includes apparatus for testing tanks, tractors and the new heavy, driven, gun-mounts. Furthermore, there has been built since the Armistice a firing range for the testing of small arms, machine guns, et cetera, and a certain area has been set apart for the testing of bombs, bomb-sights, and so on. To assist in this work, there are permanently stationed at the Proving Ground certain squadrons of flying men.

THE present article is a story of the really marvelous development in the efficiency of ordnance which has been made possible through the work of the Ordnance Department in general and the Proving Ground in particular. After the Armistice, an immediate halt was called upon the prodigious output of guns and powder for the supply of our Army and those of the Allies, and, as soon as the guns then under manufacture had passed through the Proving Grounds successfully, the activities at Aber-

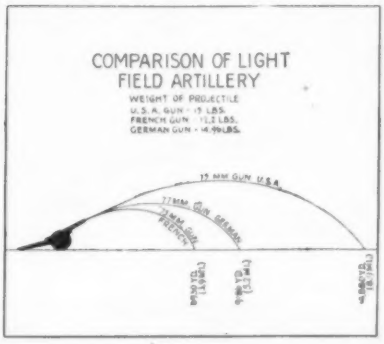
NEW 4.7-INCH GUN

At maximum elevation has range of 20,050 yards, traverse 60 degrees. Wartime gun, range 14,060 yards, traverse 8 degrees

deen quickly and inevitably slowed down. At the Armistice, the personnel comprised 272 commissioned officers, over 4,000 enlisted men and 1,200 civilian employees, to say nothing of 3,000 men employed on the construction of the plant. This personnel was finally cut down to 40 officers, 250 enlisted men and 375 civilians.

In the interval from 1918 to 1926, the staff has devoted itself to the development of new types of ordnance that should greatly exceed in range, power, accuracy and mobility, the best of the ordnance that had been developed by ourselves and the enemy during the War. We do not hesitate to say that the resulting post-war artillery constitutes one of the greatest triumphs in the whole modern field of mechanical engineering. This is a strong statement; but, remembering the great complexity and difficulty of the science and art of gun design and development, it is sufficient to look at the accompanying drawings and their descriptive captions to realize that the statement is not an exaggeration.

FOR the photographs, diagrams and general information contained in this article, we are indebted to the courtesy of Major General C. C. Williams, Chief of Ordnance, Washington, D. C., Lieutenant Colonel C. M. Wesson, Commanding Officer at the Proving Ground, and their respective staffs, and to the descriptions of our country's progress in artillery as recorded from month to month in that excellent publication *Army Ordnance*. To this data we have added our personal impressions gathered during several visits to the Army Proving Ground.

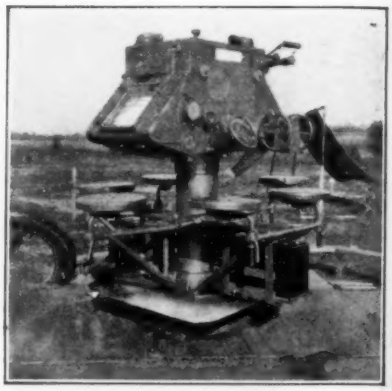


Ordnance is a term applied generically to implements of war which may range all the way from the delicate parts of a time-fuse up to the massive forms of a 16-inch gun and its mount. As an instance of delicate and highly specialized work of this kind, take the case of fuses of the shells of anti-aircraft guns.

As airplanes went higher, it was found that the old powder-train fuses, because of the changing atmospheric pressure and the failure of the train to burn at a uniform rate, were inaccurate. Therefore, the ordnance officers called in the watchmaker to design a mechanical time-fuse. There was developed a mechanism far more delicate than a high-grade watch, but sufficiently rugged to stand the shock of firing from a high-velocity gun, and being whirled around with the shell at 30,000 revolutions per minute. Consider, also, the investigation to determine the proper shape to give the bullet its highest velocity.

It was desired to take photographs of a .30-caliber bullet moving at 32,400 inches per second, and it must be remembered that, even with an exposure of only 1/32,400 of a second, the bullet would move one inch. The time had to be cut down. By using an electric spark and by damping the discharge, the time was reduced to one ten-millionths of a second and a sufficiently sharp photograph was secured. The air "bow wave" and the "wake," or partial vacuum back of the bullet, were clearly shown, and out of this investigation came a bullet, with a long pointed nose and a "boat tail" after portion, which gave the best results and added unbelievably to the range of a bullet using the same charge of powder.

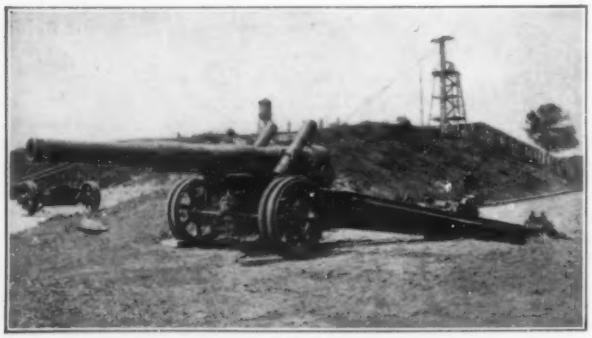
As a result of this investigation the range of the bullet was increased from 3,500 to 5,700 yards, and this was done without changing the cartridge case or the gun.



THE FIRE DIRECTOR

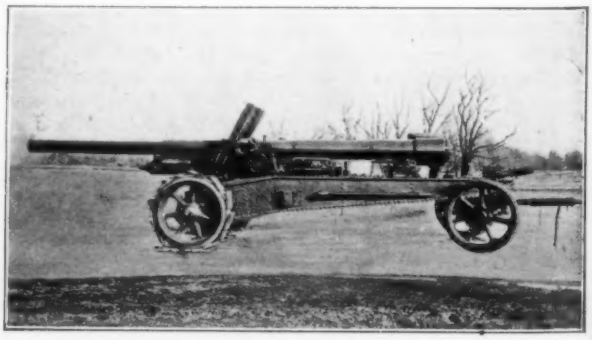
This remarkable machine automatically determines the height, range and speed of enemy aircraft and transmits data to battery

BECAUSE of the tremendous air blast, the camera could not be used for large projectiles. Here the higher mathematics of the astronomer were called in to solve the problem. These computations, coupled with many experiments in the wind tunnel, gave a six-inch projectile with a range, from a greatly improved, gun, of



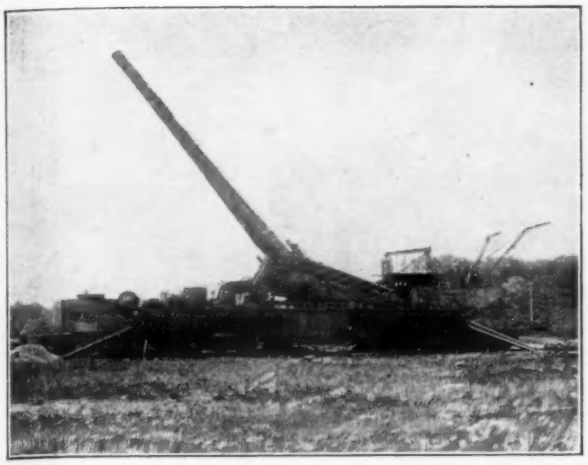
NEW 155-mm. GUN ON NEW MOUNT

Greatly superior to wartime 155. Range now, 26,000 yards; wartime, 17,160 yards. Split trail gives 60 degree traverse



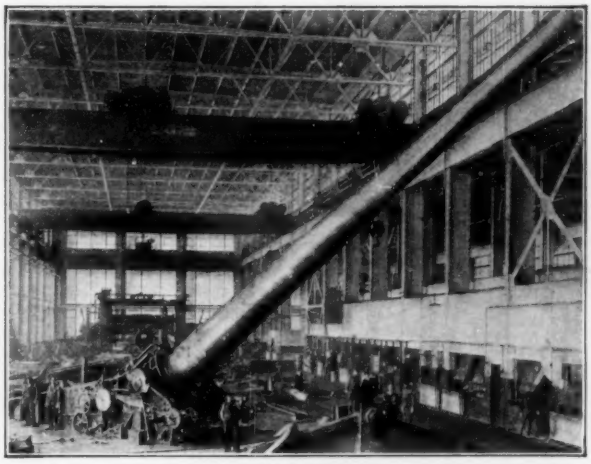
EIGHT-INCH HOWITZER ON NEW MOUNT

Throws 200-pound shell 18,700 yards. Range of wartime howitzer 12,600 yards. New 155-mm. gun uses same mount



FOURTEEN-INCH GUN ON RAILWAY MOUNT

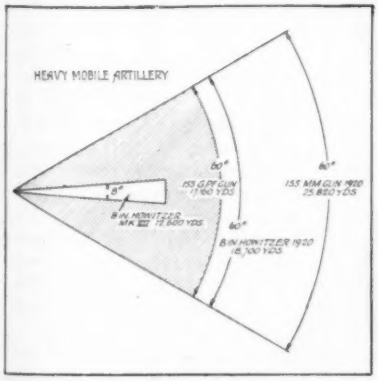
Throws a 1,560-pound projectile 45,000 yards. This gun was transported by rail to the Pacific Coast



THE 16-INCH GUN IN THE SHOPS

This dramatic picture shows the gun at high elevation. Note the scale afforded by men standing by

25,850 yards as against 17,160 yards, the range of the pre-war shell of the same caliber. Not only was the range greatly increased, but all modern field guns, except those of the heaviest caliber, are now provided with a double or split trail, as shown in the accompanying photographs. On the original single trail, the gun could be trained in azimuth, that is to say in the horizontal plane, only a few degrees; but by the use of the wide open, split trail, the traverse, as it is called, of the gun, has been enlarged to the



extent shown in the accompanying line drawing.

The vast increase in the area which can be covered by a single gun has rendered the modern piece an enormously more potent weapon than the type which was used in the World War.

The metallurgist has fulfilled his part, and a very important part it has been, in the development of our post-war artillery. By the development of a suitable alloy steel, and subjecting it to suitable heat-treatment, guns of much greater caliber-length, able to withstand higher powder pressure, have been provided. Hence the increased ranges mentioned above have been obtained without any increase of weight or loss of mobility of the gun—an important consideration.

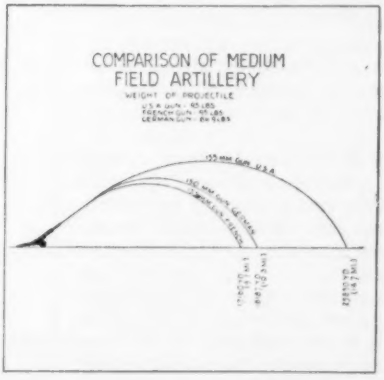
Another notable improvement in mobility has been secured by mounting guns up to 9.5 in caliber upon motor-driven caterpillar mounts. This development, it is true, began before the close of the war; but since the Armistice, it has been carried to such a point of efficiency that by the judicious use of rubber with its consequent reduction of shock and saving of energy, the speed of the smaller units has been raised from five miles per hour up to, in some cases, as high as 30 miles per hour. Moreover, the engines have been waterproofed and the tractive effort has been so greatly increased, that the tractor can be driven through water and the tractor-mounted gun can climb a 45-degree grade without difficulty. The maneuvering ability in fact has been developed to a point "where no human being could dodge it in an open field."

We do not know what the other artillerists throughout the world have been doing during the past nine years; but, in view of the great advance which has been shown at Aberdeen, it is reasonable to believe that we can, today, at least hold our own and probably surpass the artillery performance of any foreign nation.

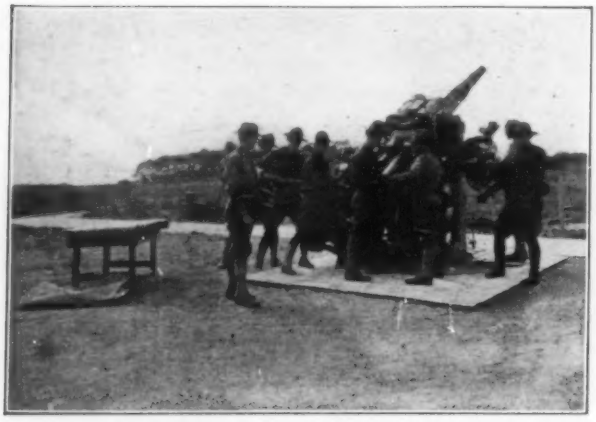
NOW, let us turn our attention to the shoulder rifle—the great weapon of the infantryman. Even before the commencement of the World War, our "Springfield" was probably the finest regulation army rifle to be found anywhere in the world. It is stated on official authority that during the war, allied soldiers would "pick up and cherish our Springfields whenever they found one on the field of battle."

The Springfield, of course, was hand-operated. Between each shot, the infantryman had to go through the operations of lifting the bolt, withdrawing it, pushing it forward, and pulling it down and locking it—all these movements having to be gone through before the next aimed shot. This prevented the sight being held continuously on the target. To enable this to be done, there was developed the semi-automatic shoulder rifle, which automatically ejects the empty shell and places another cartridge in position. Today, all the rifleman need do is to hold his sights on the target and pull the trigger.

The automatic machine gun, which is used when it is desired to pump a stream of lead over enemy troops or at an enemy position, was, of course,

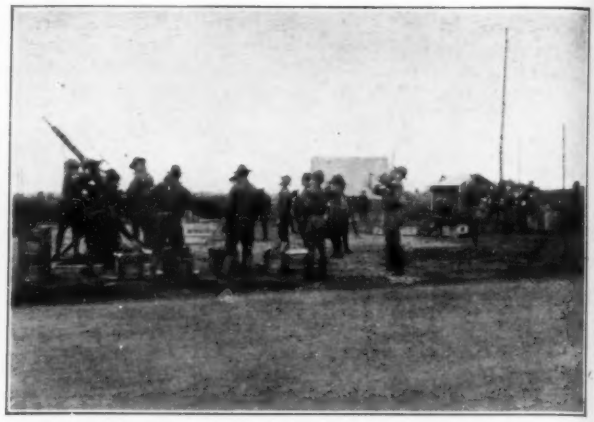


developed long before the war; but like every other weapon, it was improved during and since the war, and the Browning machine gun represents, in the opinion of our artillerists, the highest development of machine guns of the .30-caliber type. But, the great demand made upon the machine gun by aerial combat and by anti-aircraft gunners, led to a demand for a larger caliber with greater range and accuracy. Hence, since the war, we have developed the .50-caliber machine gun,



NEW 3-INCH ANTI-AIRCRAFT GUN

Fires 27 aimed shots per minute to a height of 25,000 feet and with a range of 6 miles



NEW FULLY-AUTOMATIC 37-mm. GUN

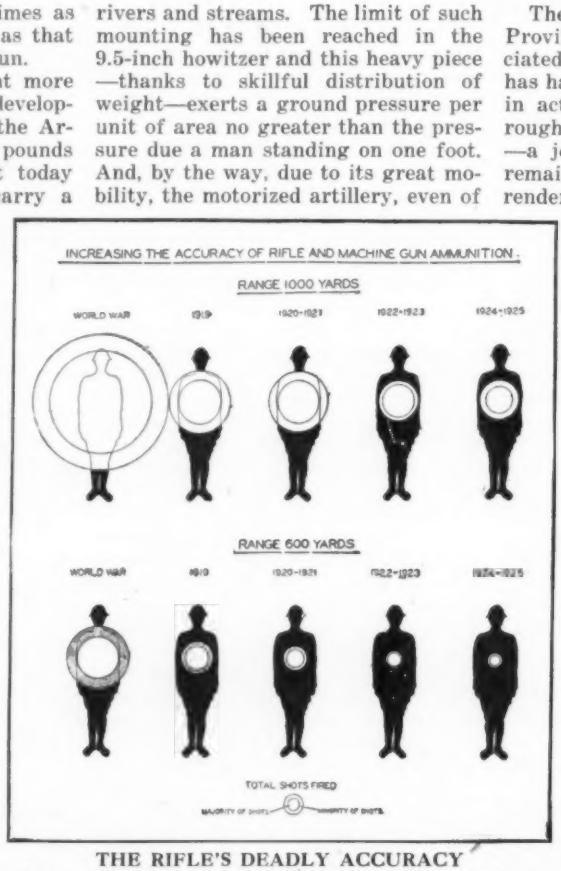
Fires a 1¼-pound explosive projectile at a rate of 120 shots per minute. Range 1½ miles

which throws a bullet four times as heavy and three times as far as that of the .30-caliber Browning gun.

Limitations of space prevent more than a brief reference to the development of airplane bombs. At the Armistice, a bomb weighing 500 pounds was considered powerful; but today the large army planes can carry a bomb of 4,000 pounds containing a ton of high explosive. The size of the individual bomb is today governed by the lifting ability of the airplane.

Returning to the matter of motorized artillery, the experts of the Ordnance Department have this to say:—"When the Ordnance engineer mounted his new long-range 'Seventy-Five' directly on the new 15-mile-per-hour caterpillar tractor, he blazed the way for artillery development of the future." This development is one of the outstanding features of the ordnance developed since the war. There is no question that automotive transport will ultimately displace horse-drawn transport; for motor transport is cheaper; its gas and oil are less bulky than forage; it requires fewer men to operate; it is easier to ship; it occupies less space on the march; never grows weary; is less vulnerable than horse-drawn transport; it is more sanitary and, a most important point, it can be camouflaged more easily.

WE heard much about the .155-(6-inch) gun during the war. The post-war piece of this caliber outranges the World War piece by nearly five miles. It has been mounted on a caterpillar tractor which can carry it at a speed of 15 miles per hour; it can climb a 45-degree grade, and can ford rivers and streams. The limit of such mounting has been reached in the 9.5-inch howitzer and this heavy piece —thanks to skillful distribution of weight—exerts a ground pressure per unit of area no greater than the pressure due a man standing on one foot. And, by the way, due to its great mobility, the motorized artillery, even of the great weight of the 9.5 piece, can be moved quickly, as soon as its position has been located by the enemy. With automotive artillery, a number of positions can be selected in advance, firing data computed for each, and at the proper time, the self-propelled mount can move to each position in turn, fire a few rounds (the engine meanwhile running) and before the enemy battery locates its position, it can pull out and move elsewhere.



THE RIFLE'S DEADLY ACCURACY

Tests made with rifle rigidly clamped in a mechanical rest. No trained sniper, of course, could equal this record

The development of tanks at the Proving Ground can be fully appreciated only by one who, like the writer, has had the opportunity to study them in action on ground selected for its roughness. The celebrated Mark VIII —a joint British-American design—remains the standard; but it has been rendered more efficient by many improvements, conspicuous among which is the stroboscope which is carried in a cylindrical sighting turret on the roof of the tank. This is provided with narrow, vertical slits and a concentric vertical, rotating cylinder. By this arrangement, the officer is well protected by armor and yet has a practically clear and continuous vision.

NO article describing Aberdeen would be complete that failed to mention the wonderful development in anti-aircraft artillery. We have spoken already of the great post-war increase in the range of the anti-aircraft .30-caliber machine gun and of the even more striking increase of power and range of the anti-aircraft .50-caliber gun. Although the bullets from these will reach and perforate the fabric of an airplane and may, once in a while reach the aviator himself, it was proved in the World War that a machine could come back, with its wings and fuselage heavily perforated with bullet holes, and yet be perfectly manageable. Evidently, something larger than a bullet hole was necessary, and hence the Aberdeen artillerists have developed a wonderful little gun—the light 37 mm.—which has great rapidity of fire, great range, and carries a fuse so sensitive that it is detonated even by the faint resistance offered by the fabric of an airplane wing.

Not only do its bursting shells tear a large hole in the fabric, but the fragments will be scattered like those of a shrapnel shell.

THE anti-aircraft 3-inch gun—thanks to a new system of director-firing and generally improved mechanism—is a vastly more effective piece than that of 1918. The progress in the work of improvement has been continuous and is still going on. Thus, at a test at Fort Tilden in 1925, with 3-inch wartime guns, ten shots were fired per gun per minute, at a sleeve target towed at 80 miles per hour at a range of 4,000 yards; and 5 percent of hits were secured. In the following year, 1926, the latest 3-inch guns were tried out at a similar target towed at 80 miles per hour at about 5,000 yards range. The average rate of fire was 22 rounds per gun per minute, and the average hits reached an average of 12 percent. Not only has the rate of fire of the anti-aircraft machine gun been increased, but as many as four machine guns are being placed in a new multiple mount which means that if each gun is capable of, say, 500 shots per minute, the man at the trigger can deliver a stream of 2,000 shots per minute against an airplane. The new "director," a photograph of which is herewith reproduced, makes it possible for the officers who operate it to determine the speed of an airplane, its elevation, changes of course, et cetera, and send this data by connecting cables to every gun of a battery. Carried upon the gun mount are electric motors which, in response to the electrical impulses from the tractor, give the gun changes of elevation and traverse necessary to insure that shell and airplane will meet at a predetermined position in the heavens. The vertical range of the 3-inch and of a new 4-inch gun of high velocity is such that no existing airplane can rise beyond its reach—all of which means that the airman of the future is going to have a pretty hot time of it when he passes over the terrain occupied by the forces of the enemy.

A word must be said about the great guns which have been developed for coast defense and which will be either emplaced in fixed fortifications or will do their firing from railway mounts traveling upon strategic railways located along the coastline. Guns too heavy for transportation by tractor are carried upon what are known as railway mounts. The latest models

BROWNING .50 CALIBER MACHINE GUN

This water-cooled gun far exceeds the .30-caliber gun in range and height of trajectory

can transport both the 14-inch .50-caliber gun and the 16-inch high-angle fire howitzer. The 14-inch gun can hurl a 1,560 pound shell for 45,000 yards, and the 16-inch howitzer throws a 2,340 pound shell 55,000 yards. These railroad mounts have given our heavy artillery a wonderful mobility. The 14-inch gun, here shown, was transported by rail from the Atlantic to the Pacific coast.

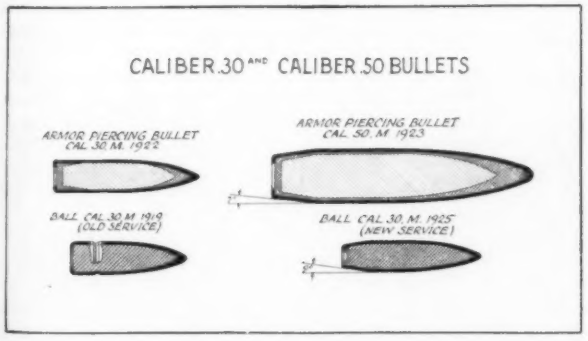
The heavy, long-range gun, on railway mount, will undoubtedly play a great part in future coast defense. Its potentialities were shown in the Turkish defense of the Dardanelles, where heavy pieces, shifting continually from place to place along the shore, proved very baffling to the attacking ships of the allies. The weakness of fixed defenses, such as the forts which defend the entrances to our leading ports, lies in the fact that their exact position is known, and when the heavy guns have been located by their flash and by airplane observation, they may be subjected to accurate and sustained long-range bombardment.

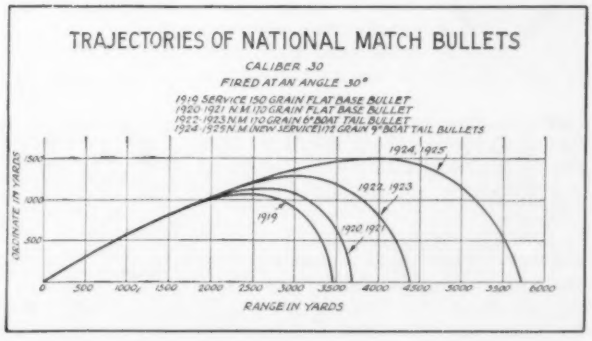
The heavy gun, rail-mounted, is subject to no such disadvantage. The military tracks for such artillery would be located near the coastline; but they would be so placed as to take advantage of the cover offered by the natural features of the ground, such as bluffs, woodland, sand dunes, etc. Upon its location by the enemy, the gun would be moved over the rails to a new site from which it would open up on the enemy with little delay.

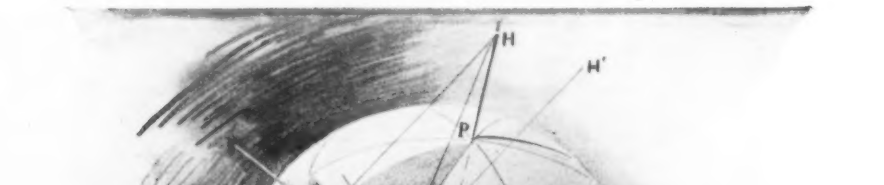
THE most powerful gun in the country today is the 16-inch, .50-caliber gun, which can hurl a 2,340-pound projectile over 55,000 yards. This weapon is more powerful and has a greater range than any gun now mounted, either ashore or afloat. Its armor-piercing shell, by the way, will penetrate 14 inches of face-hardened armor at any range.

Just here let it be said that the Aberdeen Proving Ground represents the most effective means of preparedness available under existing conditions in the United States; since, by providing standard ordnance of the very highest quality and preparing sets of jigs for each weapon, the War Department, in the event of war, will be able at once to start the vast industrial plants of the country upon the task of manufacturing the necessary ordnance, without the intolerable delay which occurred when we found ourselves suddenly enlisted in the World War.

Says Mr. D. M. Edwards of The National Association of Manufacturers: "Should war unhappily come again, it will be won by masses of men at the front and the massed intelligence of industry back of the lines. Had our nation been as well equipped when it entered the war as it is today, instead of taking eight or nine months to get into action, it would have meant the saving of a million or more lives and millions of dollars worth of property."







Watching the Earth Turn Over

The Famous Pendulum Experiment which Makes Visible the Earth's Rotation May be Performed with Simple Apparatus

By RUSSELL W. PORTER
Optical Associate, Jones and Lamson Machine Company

ONCE in a great blue moon you will run across someone who believes that this old earth of ours is fixed rigidly somewhere in space, and that what we see in the heavens —the sun, moon, stars and planets—is circling about us. And I fear some of us would be hard put to it to prove that our globe, and not the other objects, is doing the rotating.

A pretty strong argument against a non-rotating earth would be this: were we immovable in space, the more distant stars would have to revolve faster than those nearer to us, in order not to change their relative positions in the heavens. But we now know enough of star distances to make any such assumption at least highly improbable.

Apart from any astronomical considerations, there are at least three proofs of the earth's rotation. As far back as 1697 Newton suggested that an object dropped through a great distance—in this case a mine shaft—should strike the bottom a little east of a point directly beneath the point of projection, because the top of the shaft is moving more rapidly than the bottom. In the 500-foot drop available the theoretical deviation was about an inch. And the means of a large number of trials was in fair agreement with this theoretical value.

Let Us Hear From You

Following numerous requests we publish definite specifications for constructing the apparatus needed to perform the famous Foucault pendulum experiment. Such information has always been relatively hard to obtain. The author of the accompanying article has, however, both constructed the apparatus and made the experiment. Mr. Porter has been in turn polar explorer, architect and inventor, and is now attached as Optical Associate to a famous industry. It was he also who fathered the *Scientific American* amateur telescope making campaign. If you perform the experiment please advise us how it worked out. ***The Editor.***

Another proof depends on the property of the gyroscope of maintaining the direction of its axis invariable in space (unless acted on by disturbing forces). Consequently the earth will appear to rotate under the gyroscope.

The experiment to be described here is, however, that of the simple pendulum. The man to whom we are indebted for this demonstration that the earth turns over, was that wizard of the last century (1819-1868), Leon Foucault. Not only did his remarkable ingenuity in experimental physics give us a fundamental proof of the earth's rotation, but also a determination of the velocity of light and a priceless method of testing optical surfaces, one application of which was described recently in the SCIENTIFIC AMERICAN in connection with the making of mirrors for reflecting telescopes.

The consideration which led Foucault to perform his famous experiment was simply this: a perfect pendulum will continue vibrating in space in the direction in which it was originally set swinging, independent of any rotation of its support about its point of suspension. Therefore the earth will be seen slowly turning beneath the pendulum, just as in the gyroscope experiment. Not only does it

show the fact of the earth's rotation, but its direction. To one looking down on the northern hemisphere this is counter-clockwise; or, as we ordinarily state it, the earth turns from west to east.

When he performed his classic experiment, 75 years ago, Foucault hung his pendulum from the dome of the Pantheon in Paris. The suspending wire was nearly 200 feet long and the ball weighed about 80 pounds. As the pendulum swung back and forth, the needle which projected from the bottom of the ball traced its path in a tray of sand. And the *tray* was seen to turn!

The announcement made a profound impression on the scientists of the time, as it provided a proof of the earth's rotation, independent of any astronomical observations.

This famous experiment is referred to in all textbooks of physics, but with a total disregard to the practical details necessary to help the fellow who wants to do it himself, and it is this lack of definite information that prompts the present article.

I recently constructed a Foucault pendulum, and when it became known in the large industrial organization with which I am associated here in Springfield, that "Porter had a 'thing-umbob' in his office that showed the earth turning over," I was besieged by the mechanics in the shop, who came to me asking to be shown.

The demonstration gave quite a little thrill. It is so simple that the men all grasped its significance, and they would go away shaking their heads, saying, "Well, I'll be darned."

VISUALIZING THE EXPERIMENT

When performing it one has an uncanny sense of personal detachment from the earth

MY pendulum is about twelve feet long, and is hung from a steel I-beam in the ceiling. I used piano wire, and a cast-iron ball weighing perhaps 40 pounds. The effects of air resistance are reduced as we increase the length of the pendulum and the weight of the bob. Lead naturally makes the most efficient bob, but any heavy mass will do. In time, of course, the pendulum slows up, but with a three-foot initial swing my bob will still be swinging through two feet amplitude at the end of half an hour —ample time to see the rotation, which becomes apparent even after a few moments.

The pendulum must be hung from a solid support free from vibration (I have trouble when the shop machinery is running), and the air in the room must be free from drafts.

To free the pendulum from any tendency to twist I fastened to the wire a brass hook having very much the shape of an interrogation point (see drawing). The point of the hook rests in a shallow cup of steel screwed into the I-beam. The concave surface of the cup was carefully lapped smooth in a lathe, with fine emery.

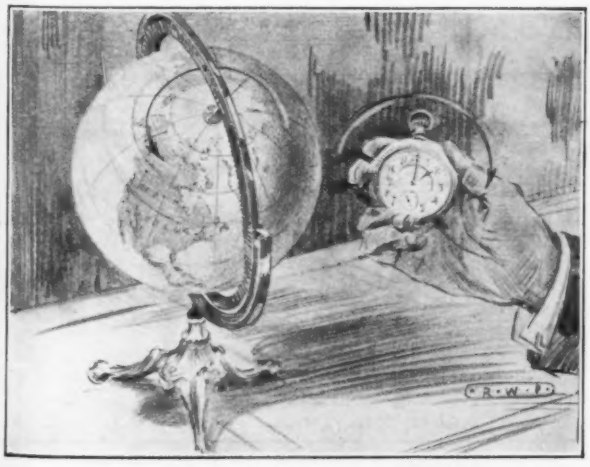
In making the experiment it is important that the bob be completely at rest before it is started swinging. To assure this the ball is drawn back with a string and, after coming to rest, the string is burned. Unless this precaution is taken the bob will tend to swing in an elongated ellipse, and any slight "looping" at the start will become aggravated as the swinging continues.

It does not matter in what direction the pendulum is set swinging. In the accompanying sketches I have depicted it swinging north and south, that is, in the meridian. However, this was done merely for clarity.

The pin or needle protruding from the ball should just clear a sheet of cardboard on the table. Draw a straight line across the cardboard and move it on the table until the line lies in the vertical plane with the path of the swinging needle.

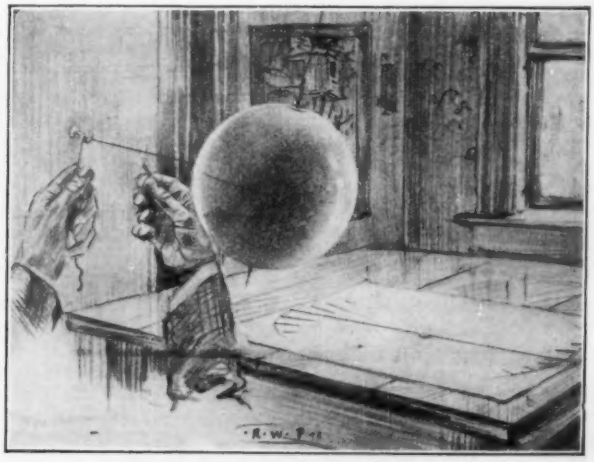
Now watch the line on the cardboard—or the southerly end of it. In a few minutes—two or three—the rotation of the earth will become noticeable. The cardboard with its line is actually turning, and its south end is moving towards the east—that is, counter-clockwise.

DR. CHARLES S. HASTINGS of Yale, now retired, tells me that in demonstrating the Foucault pendulum experiment before his classes in physics, he used a bob of cast iron some four inches in diameter, and a piano wire about sixteen feet long. He found that knife-edge suspension was not as efficient in preventing looping as allowing the wire to rest in a V-grooved support at a slight angle (shown at A in one of the draw-



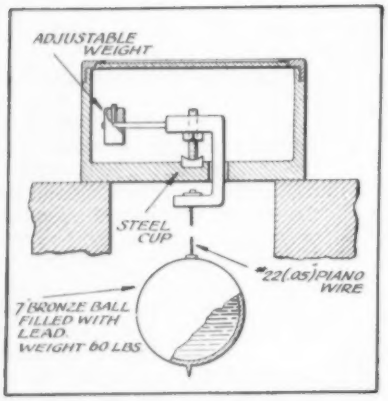
HOW THE EARTH ROTATES

The rotation is counter-clockwise in the northern hemisphere, but goes with the hands of a clock in the southern hemisphere



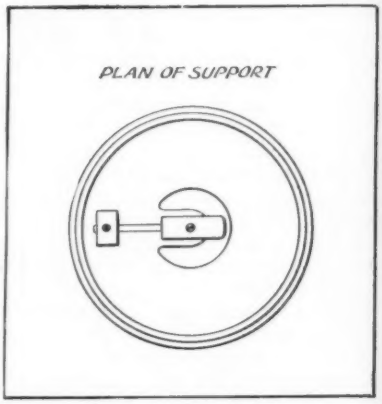
STARTING THE PENDULUM

It is held back by a string until it comes to rest. The string is then burned. These precautions are essential to success



ANOTHER METHOD

Elevation drawing of the pendulum installed at the National Academy of Sciences



VIEW FROM ABOVE

Plan drawing of the installation shown in elevation in the drawing at the left

ings). He remarked on the close agreement of the measured rotational rate of the pendulum with theory, usually with less than ten percent of error, even during as short an interval as 15 minutes. He used a hard brass wire which would not carry more than two (perhaps three) times the weight of the bob. This is probably not unimportant.

There remains the mathematical demonstration of the rate of rotation of the pendulum for any given latitude. It is obvious that if the pendulum were to be set swinging at the north pole, the cardboard and the earth would make one complete rotation under it in 24 hours. At the equator, on the other hand, there would be no rotation of the cardboard with respect to the plane in which the pendulum swings.

For positions intermediate between pole and equator let us consider an observer at some northerly latitude, O (see drawing at top of page 12). Here the pendulum is set swinging north and south, OH. After an interval (t) the rotating earth moves the position of the observer to O′H′. But angle H′O′H=angle OHO′. The arc OO′ is common to OHO′ and O-center of earth-O′. Whence,

$$\frac{\text{OHO}'}{\text{O-center-O}'} = \frac{\text{O-center}}{\text{OH}} .$$

But O-center divided by OH is the sine of the latitude, for the rate of rotation, $\frac{\text{OHO}'}{t} = \frac{\text{O-center-O}'}{t} \times$ sine latitude.

That is, while the earth rotates through angle O-center-O′, the pendulum, relative to the earth, rotates through the lesser angle OHO′, and therefore its angular velocity is less than that of the earth. Thus, when the earth has made one revolution the pendulum has not done so, and must be swinging in a different direction with regard to the meridian over which it was set vibrating 24 hours earlier. That this must be so seems conclusive from the above demonstration, but it is not so easy to visualize.

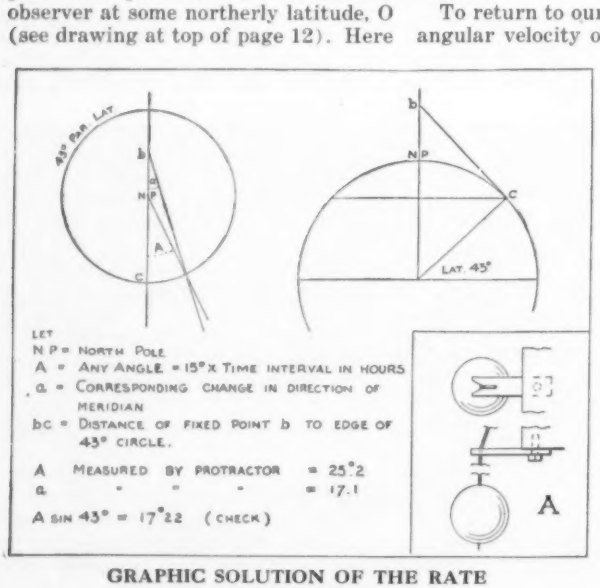
I have followed Hastings' treatment (Hastings and Beach, "General Physics, 1898," page 60), but Jones in his new "General Astronomy," page 13, employs the same steps and arrives at the same results.

Very well, if you want to exercise your imagination, get your terrestrial globe and try to figure out how this state of affairs can be. I spent one evening with several Springfield amateur astronomers, trying to unravel the mystery, but it was given up in despair. Perhaps some reader of the Scientific American will take pity on us and send us the answer.

To return to our demonstration: the angular velocity of the observer O is, of course, 15° an hour. Therefore the rate of rotation of the pendulum, OHO′, is 15° per hour × sine of the latitude. For the neighborhood of New York, whose latitude is 41° (sine = .65), the rate at which the pendulum will rotate is therefore 15° × .65 = 10° per hour.

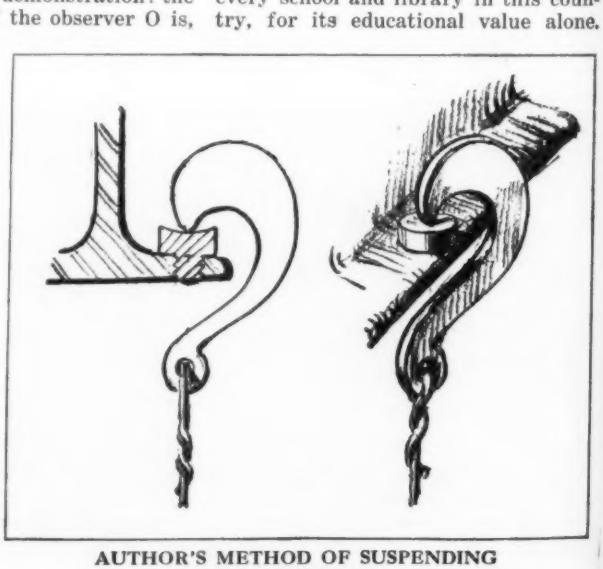
To check this in actual practice, mark off on the cardboard an angle of 15° from the central line and subdivide this angle to single degrees. Then note the number of degrees the card turns from the path of the needle. The cardboard rotates at the rate of 10° per hour—that is, at the rate of one degree per six minutes—and if the amplitude or length of swing of the pendulum is two feet, one degree on the paper amounts to about one-eighth of an inch. So it takes only a few moments to make the rotation of the earth apparent.

I would like to see a Foucault pendulum apparatus of some type in every school and library in this country, for its educational value alone.



GRAPHIC SOLUTION OF THE RATE OF ROTATION

This solution for the author's own latitude was furnished by Dr. Charles S. Hastings, eminent physicist (retired) at Yale



AUTHOR'S METHOD OF SUSPENDING THE PENDULUM

A brass hook one-eighth of an inch in thickness rests in a cup of steel, lapped smooth. This is provided to prevent twisting

OUR POINT OF VIEW

PROPAGANDA

RARELY has a word in our language been misunderstood and misused so widely as the term "propaganda." We have come to the way of thinking that if we apply the word "propaganda" to a movement for the dissemination of an unpopular truth, we have nailed that movement to the cross. So true is this, that "propaganda," in the minds of the uninstructed and unthinking majority, has come to stand for deliberate lying; so that when a man finds himself being worsted in an argument, it is more likely than not that he will throw out a sheltering smoke screen by shouting with gusto, "I and my cause are the victims of propaganda."

Now, "propaganda" is a perfectly good and wholesome word, with an honorable lineage behind it. Only during and since the World War has it been clothed with its present sinister significance. Centuries ago it originated in the missionary activities of the Roman Catholic Church and was applied to a society of cardinals who directed foreign missionary enterprise, and formed the College of the Propaganda for the education of missionary priests—a perfectly laudable enterprise as everybody surely will admit. In this sense, any body of men who are associated for the dissemination of some truth or doctrine may be called "propagandists," and it is only when such united effort seeks to distort the truth, and disseminates what it knows to be hurtful and trouble-making lies, that the term takes on its sinister meaning.

UNADULTERATED NERVE

THAT modern advertising has become a potent force for good, no one of intelligence even wishes to deny. Long past is the day when the owner of a business regarded dubiously—"as good as thrown away"—the 5 percent of his annual earnings which advertising men urged him to "forego this year, that profits might be all the greater next year." Long ago has the phrase, "It pays to advertise," become trite with acceptance; one would find it no more necessary to go about urging that two and two make four, or that the sun rises in the east.

More recently we have seen how great advertising campaigns are conducted. Given the money, it is possible to introduce—"put over"—any worthy new product on an old market; the results are in proportion to the expenditure. But can miracles be accomplished by advertisers? Are we all such dunces that they can ram anything they wish down our throats?

The *Glass Container* is a special organ "published in the interest of all makers and users of glass containers, and the contributing industries." It advocates glass bottles for liquids, glass jars for foods, and, almost, glass everything for everything—which is a pretty good idea. Evidently, however, its editor believes rather fully in the power of advertising to hypnotize the public into the belief that two and two make three, or maybe five. It seems we are all going to stop wanting fresh foods and begin craving canned foods—in glass containers, of course—and actually like it. The following is a quotation from an editorial box conspicuously printed on the front cover of a recent issue of that journal:

"The destiny of the food-packing industry," it says, "lies in the hands of the food packers themselves. If they will not attempt to make the public prefer canned to fresh products, then they will have only themselves to blame if they find themselves with a cadaver on their hands where once rested a thriving industry."

For cool, unadulterated nerve, this has anything we have read in a long time nailed to the mast. Make the public *prefer* canned to fresh products! Readers, is your intelligence and ours about to be operated on by means of "educational" campaigns so that we shall *insist* on the genuine canned foods, accepting no fresh substitutes? Will constant hammering accomplish the change of opinion? Shall we in the end find ourselves becoming indignant when well-meaning grocers try to foist on us fresh foods? Or picture yourself in a restaurant saying, "Waiter! Take away these fresh peas—I ordered canned peas!"

Few advertising men will be found to undertake such a silly campaign.

The Mississippi Lesson

THE unprecedented rainfall which caused the Mississippi flood was an act of God. The bursting of the huge flood through its artificial banks was an act of man. It is chargeable to the shortsightedness, lack of cooperation and petty local rivalries of the lay population and its non-technical representatives in Congress. The only men who understand the Mississippi problem are the United States Army Engineer Corps. Years ago they formulated a plan. Had Congress authorized the full sum needed for its execution and year by year granted the appropriations for the *continuous* execution of the project, it would, today, be completed and the flood would have passed harmlessly to the gulf. The levees, as they stand, are a chain, full of missing links.

THE CITY BEAUTIFUL

WHEN the traveler gets his first sight of Manhattan, he is fascinated by the "marvelous skyline" and justly so; for the picture presented has all the qualities of surprise, majesty and picturesque beauty. But it requires something more than a striking skyline to produce the "City Beautiful." Many of the buildings that contribute to skyline effects, are found, upon closer view, to be oppressively monotonous, devoid of any appeal to the imagination, utterly naked of any treatment that would give them architectural appeal, or place them in harmony with their surroundings. We are justly proud of the New York Public Library as a dignified and artistic work. Within the past few months, it has been overtopped by a 30-story, brick, office building, across the street, which lifts its vast, yellow, monotonous bulk into the heavens—a blazing, vertical Sahara, unrelieved by those shadow effects which a skillful artist knows how to use with telling results. And in every city there are many such. Our own Art Commission's supervisory powers should be broadened to cover the modern office building.

TUNNEL VENTILATION

RECENT preliminary and partial tests of the ventilating plant for the Hudson River Vehicular Tunnel seem to have worried the officials in charge of the work. On paper, the present plan of forcing air into the tunnel at the roadway level and drawing it out by powerful suction at the ceiling level, strongly commends itself as the most direct way to remove the monoxide gas from the tunnel. On the other hand, should a truck loaded with combustible material catch fire in the tunnel, the upward rush of air from the roadway might well serve as a forced draft to increase the heat and rapidity of the fire.

It seems that preliminary tests with combustible material, purposely set afire in the tunnel, has brought this forced-draft effect to official attention. We do not question, however, the ability of the engineers to meet this problem and solve it satisfactorily. If 10,000 feet of vehicular tunnel cannot be fully and safely ventilated, there remains the moving belt or platform, which could be so designed as satisfactorily to meet the emergency.

The Month in Medical Science

A Review and Commentary on Progress in the Medical and Surgical Field

By MORRIS FISHBEIN, M. D.
Editor of the Journal of the American Medical Association *and of* Hygeia

Stretching the Back

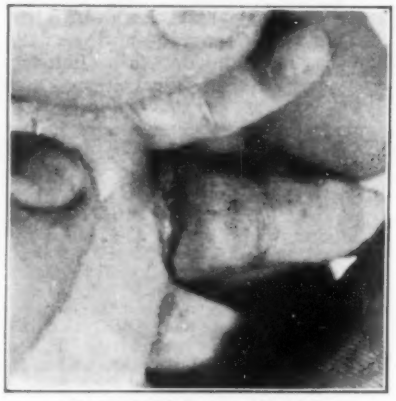
PERSONS with contracted muscles and ligaments in the back and with weak abdominal muscles are frequently told by physicians to take certain exercises that will improve the flexibility and power of the muscles concerned. A simple apparatus described by Dr. Philip Lewin consists of a one and one-half inch belt strap 15 inches long, fastened to the floor, and a small stool, 14 inches high, 11 inches wide and 18 inches long, placed as shown below. This apparatus could readily be made at home.

The subject sits on the stool and the forefeet are slipped through the strap. The hands are placed behind the head. On the count of one, the trunk is allowed to hyperextend until the head touches the floor. It remains in this position during the counts of two and three, and on the count of four the return to the starting position is made.

This exercise should be done from 10 to 20 times each morning and night, but this number is to be attained gradually. At first a pillow or soft pad is placed on the floor to receive the head, so that the extreme position is not assumed. During extension there is a combined effect of gravity resisted by the abdominal muscles. During flexion the abdominal muscles are given much work to perform and are well exercised.

Hair Encircling a Finger at Birth

DR. JAMES J. SNIPES reports to the American Medical Association the case of a child aged four weeks which was found to have a contraction around the center of the first phalanx of the middle finger of the left hand at birth. Because of the contraction, the finger was somewhat swollen and there was a slight ulceration present.



APPEARANCE OF FINGER

It is thought that the hair encircling the finger was present at the time of birth of the child

In cleaning the finger, a hair was found imbedded in the crease and completely encircling the finger. When the hair was removed the finger gradually returned to normal. So far as is known, the encircling hair was present on the finger at birth.

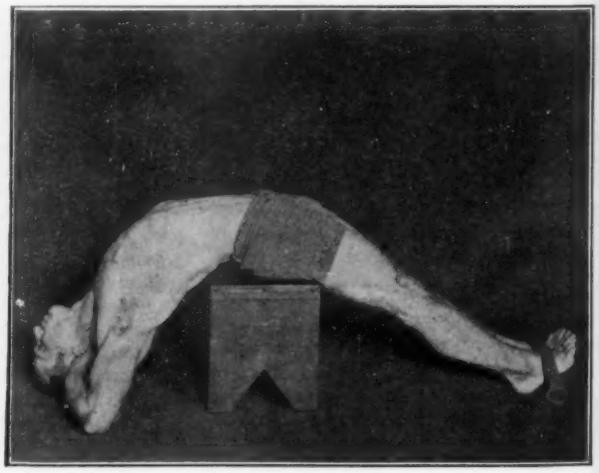
Synthalin in Diabetes

ALTHOUGH the product synthalin for the treatment of diabetes is not yet available in this country and not yet established as actually useful in the treatment of this disease, investigators abroad continue to study it with a view to determining its actual merits. A Hungarian physician, Dr. Hetényi, reported to the Budapest Royal Medical Society the results of its use in 14 cases. In ten, the drug seemed promising because when taken by mouth the patients were freed of sugar and the effect was relatively lasting. However, in four cases its use was accompanied by loss of appetite, disagreeable symptoms related to the stomach and intestines, and nausea and vomiting. In some cases the drug seemed to irritate the kidneys and women who were weak or especially nervous reacted seriously to its administration.

In view of these dangerous side effects, the Hungarian physicians believe that the advantages of synthalin over insulin, because of its cheapness and the fact that it can be taken by mouth, are not sufficient to warrant its use. It is, of course, possible that continued experimentation will develop a product free from such side effects.

FIRST POSITION

The simple apparatus for stretching the muscles and ligaments of the back, as well as those of the abdomen, is shown here in use, the exercise to be performed morning and night



SECOND POSITION

The back is arched and the abdominal muscles are exerted to resist the force of gravity. The text above gives complete directions for construction and use of this simple apparatus

A Vitamin to Control Iron in the Body

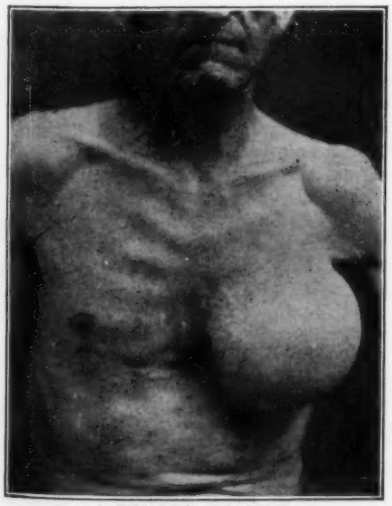
DR. NINA SIMMONDS, Miss J. Ernestine Becker and Dr. E. V. McCollum of the Department of Chemical Hygiene, School of Hygiene and Public Health of Johns Hopkins University, have recently completed investigations which indicate that vitamin E, first described by Evans and Bishop of the University of California as a factor controlling sterility, is also responsible or in some manner associated with the way in which iron is assimilated in the human body. The work done by previous investigators indicated that a deficiency of this vitamin resulted in the death of the fetuses in rats, and it is the belief of the Baltimore investigators that this death is due to a crisis in iron assimilation and that the death may be prevented by giving vitamin E in appropriate amounts from the beginning of pregnancy in the mother rat.

The authors are also inclined to associate the results of their investigations with the encouraging observations made by Minot and Murphy regarding the eating of diets containing large amounts of liver in the treatment of anemia. They point out that liver fats contain vitamin E in considerable amounts, and that the liver also contains much iron.

As a by-product of their investigation, it was found that the iron salt known as ferrous sulfate is not a satisfactory source of iron, but that the ferric citrate will serve the purpose. Wheat germ oil is also an excellent source of vitamin E.

An Unusual Tumor

AMONG the most unusual of the tumors affecting man, particularly in the extraordinary appearance that they may produce, are those composed of fat. They may appear anywhere in the body.



A TUMOR OF FAT

This growth continued for 25 years and was finally removed by a very simple operation in which only local anesthesia was used

In a case described by Dr. R. J. White of Fort Worth, Texas, the tumor affected a man 64 years of age. As shown in the picture, the tumor very much resembled a female breast. It began when the man was 24 years of age and grew intermittently until he was 49 years of age, after which it apparently ceased to grow further. The tumor was entirely of fat and did no harm, except by its unusual appearance. It was easily removed with a simple incision of the skin under local anesthesia.

The remarkable fact in the case is that anyone would continue to carry such a deformity when the removal was such a simple matter.

Treatment Timer

SINCE the coming into scientific medicine of modern methods of treatment by the use of light, X ray, continuous warm baths, and similar procedures in which the treatment may extend over varying periods of time, from a few minutes up to several hours, and in which excessive treatment may produce harm, it has been necessary to develop means for automatically controlling the applications. Such a device is the treatment timer described by Dr. H. L. Classen of Ohio.

The device correctly times periods of from one minute up to 45 minutes; warns the operator and automatically turns off the electric current after the end of the time period for which it is set; may be automatically turned off by the patient, and is automatically integrating. It is not necessary to wind it up or to control it in any other fashion than merely to turn on the switch when the device is in use.

AUTOMATIC ELECTRICAL TIMER

This device warns the patient or doctor when the time period for a certain treatment is completed

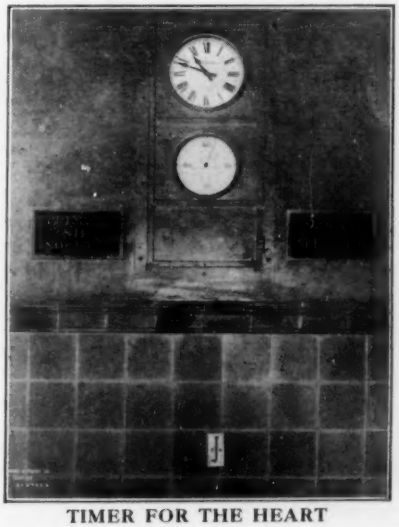
Counting the Fetal Heart Beat

DR. JOSEPH B. DeLEE, chief physician of the Lying-In Hospital in Chicago, an institution noted for its contribution to the advancement of this branch to medical science, has been able with the assistance of the firm of Vacheron and Constantin of Geneva, Switzerland, recognized as among the greatest of watch-makers in the world, to develop a watch and a clock for assisting the physician in counting the heart beat under circumstances when it is unusually rapid or heard with difficulty. This is especially important in a case of an infant previous to birth, when the fluctuations, the rapidity, rhythm or character of the heart tones may be of great significance.

Dr. DeLee is authority for the statement that it is possible to diagnose injury to the brain of the unborn child under such circumstances, and even to predict whether it will have convulsions after it is born.

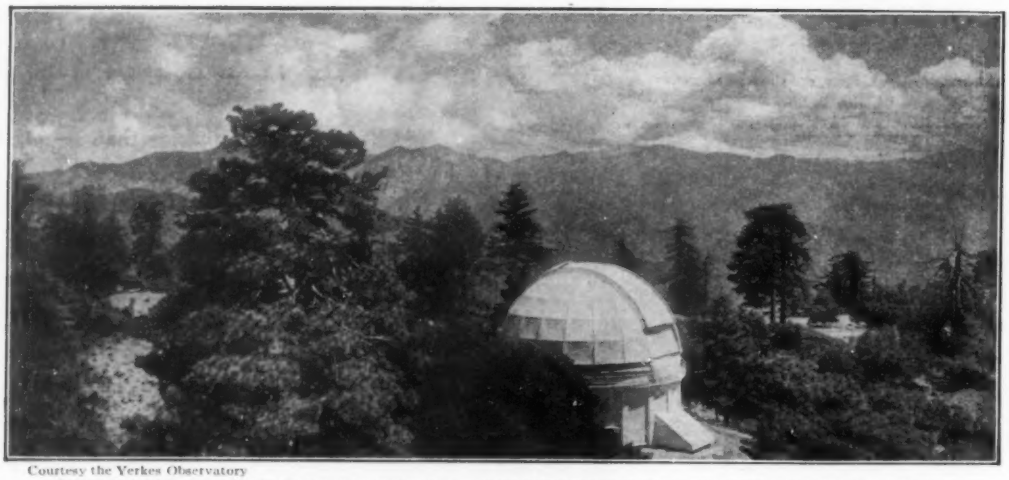
The clock shown in the illustration rings a bell every fifteen seconds. The physician listens to the beat of the baby's heart with a stethoscope that fastens to a headband and which need not be touched by hand. When the bell strikes, the physician counts the beat until the bell strikes again, which is exactly 15 seconds measured time.

A watch, slightly larger than the usual watch, is also made with a bell-ringing attachment. This size is ideal for portable use.



TIMER FOR THE HEART

The clock rings a signal bell every 15 seconds. During the interval, heart beats are counted. It is thus unnecessary to watch the clock



Courtesy the Yerkes Observatory

THE DOME OF ONE OF THE GREAT TELESCOPES AT MT. WILSON OBSERVATORY

Is Mars Habitable?

Its Habitability is Made More Probable By Recent Observations Whether it is Actually Inhabited is Still Unknown

By HENRY NORRIS RUSSELL, Ph. D.,

Chairman of the Department of Astronomy and Director of the Observatory at Princeton University
Research Associate of the Mt. Wilson Observatory of the Carnegie Institution of Washington

EVERYONE knows that astronomical observation is a trying business; the picture of the "pale astronomer" working at his telescope the whole night long is a commonplace. But, except in a few isolated fields of research, the astronomer's work has only begun when his observations are made and duly recorded. He must interpret them—and this "discussion" of his observations often takes more time and work than the making of them.

Those who do not understand this are likely to be impatient to learn the results of the astronomer's work. They know that some noteworthy event—an eclipse, a close approach of a planet, or the like—occurred months ago and they ask, "Why don't they tell us what they discovered?" Meanwhile the observers are busy finding out just what the observations have indicated—checking their results in every way they can think of, applying all possible tests, until the sheets of calculations grow into a mighty pile.

A VERY good instance of this is found in last year's study of Mars. Six months have passed since the observers were busiest with their telescopes, and the first detailed account of their conclusions has just been published—a summary of the work of Dr. Coblentz of the Bureau of Standards, in cooperation with Dr. Lampland of the Lowell Observatory.

The particular question under discussion is the very interesting one of the temperature of the planet's surface—upon which the observations of 1924 gave the world the first really trustworthy information.

We may recall that these observations are made with the aid of a thermocouple—that most delicate device in which the planet's rays heat up a tiny speck of blackened metal at the junction of two wires of different alloys—and set up a feeble electric current which is recorded by a sensitive galvanometer. By mounting the apparatus in a vacuum, and making it extremely small, great sensitiveness may be secured; one of Dr. Coblentz's thermocouples was only 1/200 of an inch in diameter. Such an apparatus, with proper precautions, measures the heat which comes in from the planet, or rather, from that particular part of its surface whose image fell on the receiving device. (The smallest thermocouple covered only one thirteenth of the diameter of the image of Mars.)

We have no time here to tell the story of the long series of researches which led to the development of the amazingly delicate and efficient devices now in use. Some idea of the care employed, even in handling the instruments, may be gained from Dr. Coblentz's remark that one instrument containing these brittle filaments as fine as hairs is "still in good condition in spite of one trip to California and four to Arizona, totalling over 26,000 miles."

Reliable measurements can now be made as a matter of routine; but how are we to interpret them? Some of the heat from the planet is carried through the ether in short waves—this corresponds simply to the reflected sunlight. The rest comes in long waves, emitted from the planet's warm surface. By the interposition of suitable filters—cells containing water, or plates of glass, quartz, or fluorspar—the waves of different lengths may be sorted out, and their relative heat-carrying powers compared.

WHEN this is done, the quest would be fairly plain sailing if only there were no atmosphere on the earth, and none on Mars; for the relative amounts of radiation of the various wavelengths given out by a standard body at various temperatures can easily be computed, and we would only have to match these with the observed data. But, as things are, the earth's atmosphere interposes an additional screen, imperfectly transparent, and varying hourly in its transmission, as weather conditions change; also as the planet's rays traverse various thicknesses of air as it raises or sinks in the sky.

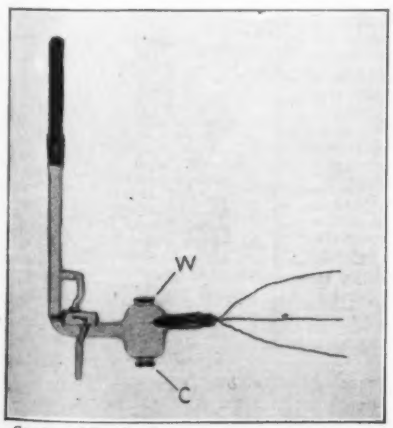
The higher the altitude of the observatory and the drier the air, the less will be these difficulties; so that Flagstaff was, in these particulars, an exceptionally good observing station.

After allowance has been made as fully as possible for our atmosphere,

there remains the difficult question of the effects of the atmosphere of Mars. We are sure that the planet has an atmosphere, although probably one much less dense than the earth's. There can no longer be any doubt that the polar caps are really composed of snow; and the presence of water vapor in the Martian atmosphere, after these snows have for the most part disappeared, has been shown by direct spectroscopic tests. Clouds, although far less abundant than on earth, have also often been observed on Mars.

What effects will all these things have on the observed radiation and the deduced temperature? Clouds and even a thin haze reflect a good deal of sunlight back into space, thus depriving the planet's surface of some of its income of heat. This influence, by itself, would make the surface cooler. But the heat which does get through the haze to the planet's surface has to get out again; and a damp atmosphere, even if not visibly cloudy, is very effective in blocking the outward passage of most of the long waves. This second influence acts as a heat-trap, and tends to warm the surface. Under certain conditions, it may considerably exceed the first in importance, and a planet with a moist, slightly hazy atmosphere may be a good deal hotter on the surface than one without such a protection. It is almost certain, indeed, that this influence is a major factor in making the temperate zones of the earth habitable. Without it New York might be as cold as Greenland is now.

DENSE clouds would produce a more nearly balanced effect, by day; but if they formed at night, they would act as a very effective blanket against the escape of heat from the surface and might do a great deal to raise the average temperature for the whole 24 hours.

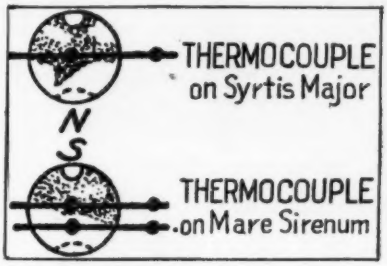


Courtesy of *Popular Astronomy*

THE VACUUM THERMOCOUPLE

The radiation enters by window **W**. *The observer's window, for sighting the couple, is at* C. *Between them the thin thermocouple shows faintly*

When, however, we consider what influence clouds or water-vapor haze will have on the observed heat radiation from a planet, we have quite another story. The short waves of sunlight are reflected back to us in larger amounts than before, while the long waves coming from the underlying surface are partly prevented from getting out. These two effects work the same way, and should cause the observed proportion of long-wave to short-wave radiation to be much diminished. For an atmosphereless surface, this would correspond to a lower temperature; hence the temperature of a cloudy or hazy part of the Martian disk, as calculated by the (relatively) simple formulae which have usually been employed, will be lower, and may be a good deal lower, than that of the actual surface beneath.



Courtesy U. S. Bureau of Standards

THERMOCOUPLE ON MARS

The tiny junctions are about the size of a period. They can be placed over any chosen part of the planet's image

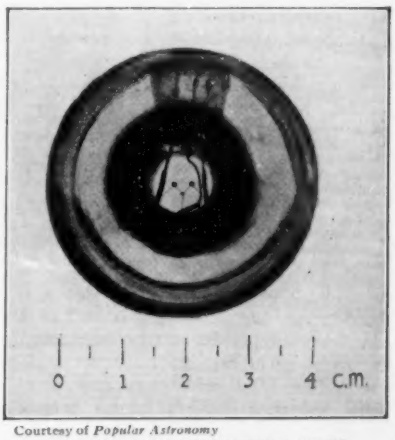
Dr. Coblentz uses this principle to explain one of the worst puzzles of the observations of 1924. The region of the polar caps, when the snows are rapidly diminishing, when tested by radiation measurements, appeared to have a temperature of —60° Centigrade, or about 75° below zero, Fahrenheit. Now it may perhaps be that the snows evaporate into dry air at a temperature a little below the freezing point, but at anything like this degree of cold they would show no tendency to evaporate at all. The actual surface temperature at the edge of the caps is, at the worst, probably about zero, Fahrenheit, and may be a good deal higher.

Similar considerations apply to the measurements upon the eastern and western limbs of the planet (when the sun is just rising or setting) which appeared to be pretty cold, with temperatures of 20°, Fahrenheit or lower. Here one line of sight penetrates the Martian atmosphere obliquely, and any effect of haze would be heightened.

Taking all these things into account, Dr. Coblentz arrives at the following estimates of the actual surface temperatures of different portions of the planet. In the south polar region —in the latter part of its summer season — the temperature probably ranges from 15° to 50°, Fahrenheit; in the south temperate zone (summer), 65° to 75°; in the tropics, at noon, 65° to 85°; in the north temperate zone (winter in rather low latitude), 30° to 60°; nearer the north pole, where the winter days are short, from 10° to 40° below zero. All these are temperatures at *noon*; at sunrise the temperature is probably not much above zero, and at sunset, perhaps 15° or 20°, Fahrenheit. The nights, even on the equator, are probably very cold, and at the sunless pole the temperature may fall very low.

ALL these results differ widely from the opinions which were held, even by the best authorities, five years ago; but they rest upon a solid foundation of measurement, and afford a sufficient base for change of the prevailing expert opinion. They are not without independent confirmation. Pettit and Nicholson, at Mount Wilson, have made similar observations. Their results for 1926 are not yet announced; those of 1924 indicated a temperature at noon in the tropics of about 80°, Fahrenheit. Coblentz emphasizes the point that the results obtained at the two observatories are *not* in disagreement, (as has erroneously been supposed by some uncritical readers). The numerical differences in the published statements depend on the fact that the corrections for the probable effects of clouds and haze have been applied in some cases and not in others.

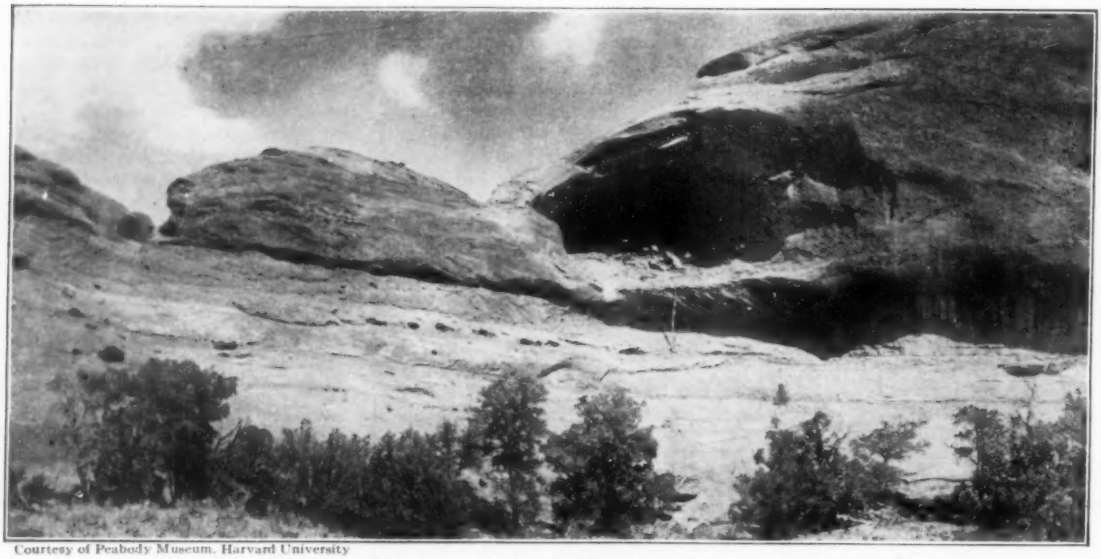
Just how great these corrections may actually be, future research must tell; Dr. Coblentz states expressly that his values are subject to further revision. But there can now be little doubt that, owing to atmospheric influences, the surface of Mars is a good deal warmer than even once supposed, and there appears to be no further difficulty on the score in regarding the planet as habitable.



Courtesy of *Popular Astronomy*

WHAT THE OBSERVER SEES

Here the reader is looking through window C *of the figure on opposite side of the page. The two round thermojunctions show quite plainly here*



Courtesy of Peabody Museum, Harvard University

EXCAVATORS AT WORK IN A TYPICAL REFUGE CAVE OF CLIFF DWELLERS

American Farmers of 4000 B.C.

A Brief Survey of the Known History of Our Southwestern Aborigines

By A. V. KIDDER, Ph. D.

Chairman, Division of Anthropology and Psychology, National Research Council

THE tremendous public interest aroused by the discovery of King Tutankhamen's tomb, and by the opening, one by one, of its treasure-packed chambers, served to put archaeology, so to speak, "on the map." Since then archaeological news from various parts of the world has been regularly on the front page of our great dailies, and the periodical press has carried an increasingly large number of special archaeological articles. As a rule, however, the press notices and the feature stories have described work done at single sites, or have recorded isolated finds of spectacular specimens; the public has had only the highlights.

If mere incidents in the great drama of man's rise from savagery can command public attention, much deeper and more intelligent interest will be aroused when the entire story can be told. The major part of that story is still to be unravelled, for even the best informed students of the human past can as yet catch only fleeting glimpses. But in some regions, because of abundant remains or fortunate accidents of preservation, the outlines, at least, of pre-history are shaping themselves. One of these regions is the American Southwest.

The Southwest, archaeologically speaking, comprises those parts of Colorado, Utah, Nevada, Arizona, New Mexico, and the Old Mexican State of Chihuahua which contain remains of the Pueblo Indians or of their cultural ancestors. The region is in general a semi-arid or arid plateau, much of it is true desert, and it is, one would naturally suppose, the very last place in which primitive man could have made unassisted any advance from barbarism. Yet here there grew up the highest civilization that was achieved by any Indian people in the United States, and that civilization was intrinsically so strong, and was so well adapted to its peculiar environment that, of all the native cultures of our country, it alone has survived to the present day in anything like its aboriginal purity. And, as I said above, we are now able to trace its history with considerable accuracy.

Long before the birth of Christ, probably two or three thousand years before, the mesas and canyons of the Southwest were roamed over by little groups of nomadic Indians. They led a hand-to-mouth existence by hunting such small game as existed in that barren land and by gathering scanty harvests of wild seeds and roots. In some way, not as yet clearly understood, there reached these people seeds

Bringing Order Out of Chaos

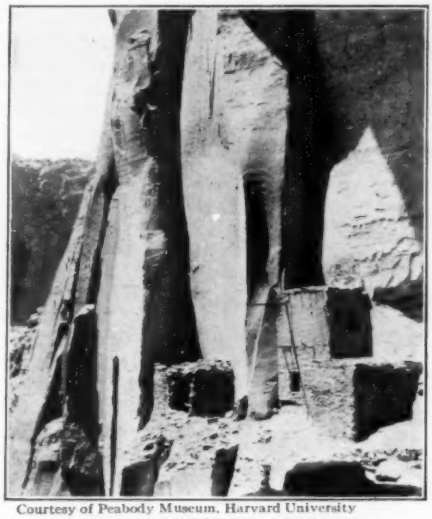
Has it been the experience of the reader, as it is that of the Editor, that a great deal has been written about the archaeology of the Southwestern States, without greatly clarifying the subject as a whole? Usually the writer, being himself an expert on his own subject, assumes that the reader already knows the fundamentals of it. And the reader usually does not.

With this in mind Professor Kidder, an authority on the archaeology of the Southwest and author of a notable recent work entitled "Southwestern Archaeology," was asked to prepare a short survey of the subject. This he has admirably done, and the reader will now have a peg on which to hang future statements about the archaeology of the Southwest.

The main periods are *approximately* as follows: Pre-Basket Maker, ? to *2000* B.C.; Basket Maker, *2000* B.C. to *500* B.C.; Post-Basket Maker, *500* B.C. to *1* A.D.; Pre-Pueblo, *1* A.D. to *250* A.D.; Early Pueblo, *250* A.D. to *500* A.D.; Great Pueblo period, *500* A.D. to *1100* A.D.; Period of decline, *1100* A.D. to *1540* A.D.; European Discovery, *1540* A.D.; Historic Period, *1540* to *1927* A.D.

of corn, the great native American cereal, which had still earlier been brought under cultivation in Mexico. They began to plant corn in favorable places, and the possession of fields that required attention, together with crops they could depend upon, gradually served to wean them from their wandering habits.

It is at this stage, this dawn of farming in our country, that we get our earliest real knowledge of life in the Southwest, knowledge painstakingly recovered by many archaeologists excavating in dusty burial caves. We see a strongly built folk, long-headed, tallish, living in little communities scattered among the gorges of northern Arizona and southern Utah. We call them the Basket Makers, because not yet having learned to mold pottery vessels, they placed with their dead offerings of beautifully woven baskets.



Courtesy of Peabody Museum, Harvard University

CLIFF HOUSES IN ARIZONA

This is part of the Betatakin ruin in northern Arizona. Another part is shown in the illustration below. Study the masonry from a structural standpoint

THE Basket Makers, according to S. J. Guernsey of Harvard, the leading authority on this period, apparently lived in perishable brush huts, all trace of which has now disappeared. They took advantage of the great caves, which occur so commonly in the canyons of the Colorado River drainage, as storage places for their crops. Holes dug in the sandy floors of the caverns, lined with stone slabs, and roofed with poles and brush, served as receptacles for harvested corn, and very often these same holes were used as burial places. When, as was often the case, the cave was protected from rain by an overhanging roof, the sandy deposits within were kept bone-dry and quickly absorbed all moisture from the interred bodies, dessicating them to mummies as perfect as those of Egypt. Nor did decay overtake the wrappings and the offerings of baskets, textiles and weapons that had piously been placed with the dead. They come from the graves as fresh and as sound as the day they were made, a thousand years or more before the birth of Christ.

Good fabrics the early Basket Makers wove, all by hand, for the loom had not yet been invented. They did not even have the bow-and-arrow, but used instead a long, light, flint-tipped dart, hurled with the aid of a peculiar wooden spear-thrower. These lances were no mean weapons, however, for in the Natural History Museum in New York there is a Basket Maker skull with a dart-point driven deep into the bone.

We know that the Basket Makers were the first agriculturists of the Southwest, because wherever we find their remains in the same cave with the relics of other people, the latter always lie above them. This simple principle of stratigraphy, which geologists and palaeontologists have utilized to reconstruct the history of the earth and the succession of extinct types of animals, has also been of the greatest value to archaeology, particularly in such regions as Arizona, where many successive peoples lived in the same places. Among other things, it enables us to recognize the later stages of the Basket Maker culture.

This later period, which is called the "post-Basket Maker," brought with it no change of race. The mummies and the skeletons are all of the same long-headed people. But they had made two most important discoveries: that clay could be molded into vessels and made hard and watertight by burning; and that flat stones piled one upon another would make a wall. These beginnings of architecture and of the pottery art were not carried far by the post-Basket Makers. They were long satisfied with crude vessels, and during the centuries of their occupancy of the region they hardly erected a house worthy of the name. But the discoveries had been made, and it needed only the energy of a new people to carry them forward.

Certainly not much later than the year 1, quite likely earlier—the dates of these remote periods are still very uncertain—the new people arrived. They were a round-headed folk, shorter of stature and lighter of bone than the Basket Makers and their descendants the post-Basket Makers.

IT is hard, in the present fragmentary state of our knowledge, to make even an intelligent guess as to where they came from, but in view of the fact that deserts, mountain ranges and great canyons make formidable barriers to the north, northwest and west, it seems likely that they filtered in from the south or the east. Of these two directions the south seems perhaps the more likely, as the agricultural nations of central Mexico may well, about this time, have been expanding to such an extent as to set up an outward pressure, thus causing northward movements of population.

At all events, the new people arrived in the post-Basket Maker country, and eventually replaced the old long-headed type. I referred above to this immigration as a filtering, and such it seems to have been, for there are no signs of a sudden destruction of the post-Basket Makers. Furthermore the newcomers took over the old way of life practically as it was, and this they could hardly have done had they swept over the country as a Hun-like horde. Earl H. Morris has, indeed, found evidence that the two races lived for a short time mixed together in the little canyon communities.

Courtesy of Peabody Museum, Harvard University

BETATAKIN CLIFF HOUSE

The straight, nearly vertical black line above the center is an ancient pole used by the former occupants. By shinning up it one can reach a spring on a ledge

The new people we call the "pre-Pueblos." They were without doubt the direct ancestors of the Pueblo cliff-dwellers of the later prehistoric periods and, in turn, of the Hopis, Zunis and other present-day Pueblos. They took over the culture of their predecessors practically unchanged. They built the same sort of crude houses, and made only slightly

better pottery. But they eventually began to group together in larger settlements, to improve their dwellings by raising higher walls of masonry, to fashion better and decorate more elaborately their earthen vessels. Cotton also seems to have appeared at about this time, and the bow began to be used.

PROGRESS was slow and it probably took some hundreds of years to develop the compact house-cluster of solidly built rectangular rooms that is usually considered to mark the opening of the Pueblo period. The early part of this period is remarkable for the rapid extension of agricultural communities in the Southwest. The post-Basket Makers and the pre-Pueblos seem to have had a somewhat restricted range in northeastern Arizona, northwestern New Mexico and nearby regions in southern Utah and Colorado. The early Pueblos, however, spread out far and wide from this center and the remains of their villages are found over a vast extent of territory. Conditions were evidently most favorable for them, the climate was perhaps slightly more moist than it is today, and it is certain that they were in little, if any, danger from human enemies. This is proved by the fact that their towns were small, were widely scattered and were not built with any reference to ease of defense.

These good times, which apparently lasted until the sixth or seventh centuries of our era, were brought to a close by the arrival in the Southwest of nomadic foes. Again, we do not know who they were, but their onslaught was evidently ferocious, for they very quickly caused the abandonment of practically all the outlying regions, and forced the Pueblos to gather together in the central and

Courtesy of the Peabody Museum, Harvard University

BASKET MAKER MUMMY

The wrappings consist of brightly colored textiles

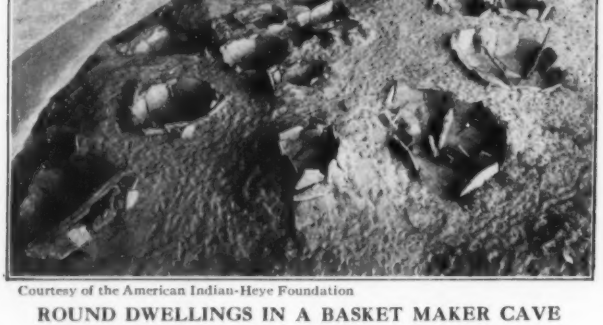
southern parts of their old range.

There now opened the Great Period of Southwestern history. The Pueblos had been obliged to congregate in a more or less limited area. Large towns gathered to themselves the inhabitants of the little scattered villagers of former times. Community of interest stimulated community of effort. The necessity for protection against attack led to the selection of easily defensible house sites or, if such were not available, the building of compact, fortified structures sheltering hundreds of families. This was the era of the cliff-houses, those dizzily placed dwellings in caves and on high ledges, that have aroused so much interest and speculation.

To the Great Period belong Cliff Palace and Sprucetree House in the Mesa Verde National Park; Betatakin in the Navajo National Monument; and the many cliff-houses of Canyon de Chelly. During the Great Period also were built Pueblo Bonito and the other huge village of Chaco Canyon, now being excavated by Neil M. Judd for the National Geographic Society. It was a time of great achievement, both in architecture and in all the other arts; pottery-making flourished, weaving was brought to great perfection and it is probable that there were developed some of the elaborate ceremonies such as the Snake Dance, which are still carried on by the Pueblos of today.

WHAT caused the abandonment of the prosperous communities of the Great Period is still uncertain; possibly drought, possibly further attacks by strengthened foes, possibly inbreeding due to isolation of units of population. All we know now is that they were abandoned, most of them, presumably, about 1100 A. D. No cliff-house, nor any one of the great northern pueblos was occupied when the Spanish arrived in the Southwest in 1540. Between these two dates the Pueblo Indians were forced or migrated into the territory along the Rio Grande and in the Little Colorado drainage, where they live today.

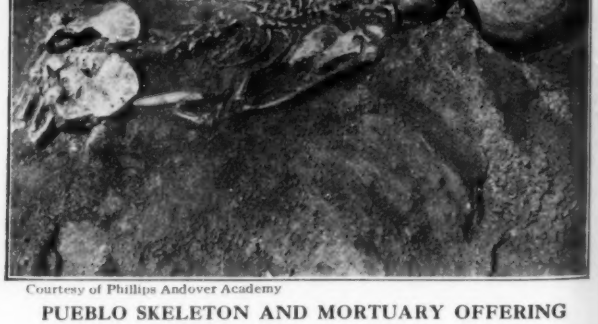
This is a very brief outline of the history of the Southwest. Nor can we today write with confidence anything more than an outline. But further excavation will fill in the details, further study of the ruins, of the pottery, and of the skeletons will tell us much that we do not yet know as to the cultural and racial relationships of these most interesting peoples of the American Southwest.



Courtesy of the American Indian-Heye Foundation

ROUND DWELLINGS IN A BASKET MAKER CAVE

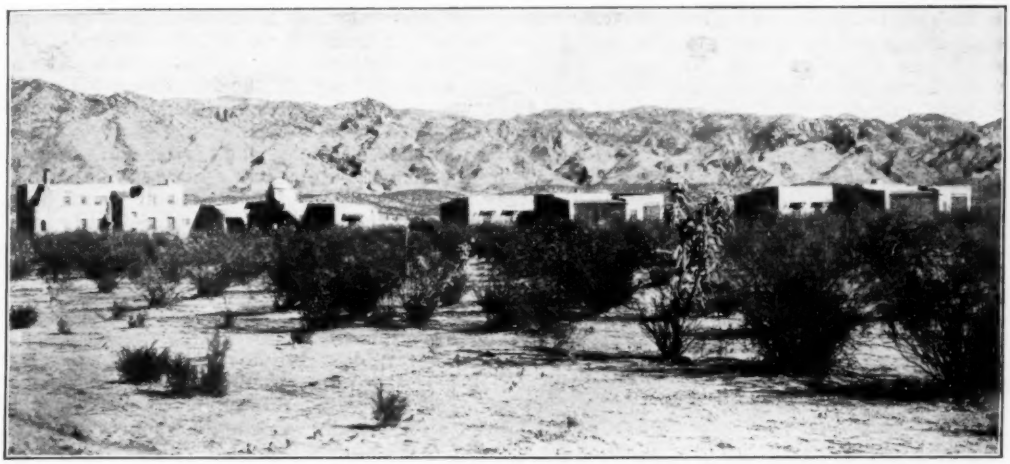
The scale of size is given by the figure of a man just above and to the right of the center



Courtesy of Phillips Andover Academy

PUEBLO SKELETON AND MORTUARY OFFERING

The offering consists of a baked clay pot which may be seen at the right, near the skull



THE DESERT SANATORIUM AT TUCSON, ARIZONA

The curved dome of the radiometer for measuring daily variations in the intensity of the sun's ultra-violet radiation shows at the left of the center

Sunburn in the Dark

Treatment With Isolated Ultra-Violet Rays from the Sun

By D. T. MacDOUGAL

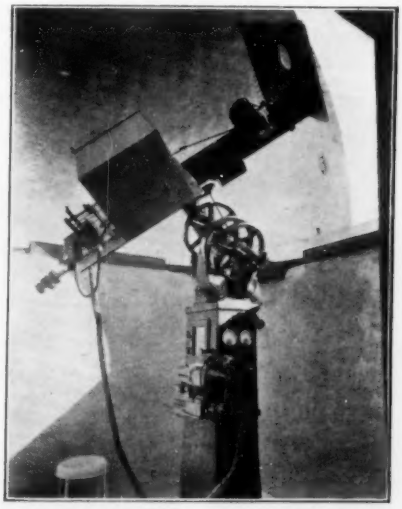
Director, Laboratory for Plant Physiology, Carnegie Institution of Washington

MOST solids and liquids as well as our skins are warmed by the sun's rays. But the fact that the most pronounced cases of sunburn of our faces and hands do not occur on the hottest days or in the regions having the warmest climate, suggests that it is neither visible light nor the so-called "heat rays" beyond the visible red rays in the spectrum of sunlight that causes pigmentation and tanning of the skin. And such a suspicion would be well-founded, for sunburn or similar effects may actually be experienced in radiation which does not give much illumination.

RADIANT energy from the sun exercises highly specific effects according to its wavelengths. For example, when sunlight, which has passed through a solution of green coloring matter (chlorophyll) from the leaves of plants, is spread out to make the rainbow play of primary colors, dark gaps or bands will appear mainly in the region of the blue-violet and red in which the rays have been stopped by the chlorophyll. The energy in that part of the light which is absorbed by the plant is converted into power by which the leaf-mills manufacture sugar and other substances which enter into living matter. This process is absolutely fundamental to life in all of its forms.

Many fads and fancies as to the use of various parts of the spectrum have had wide vogue at various times; yet none greater than the "blue-glass" craze of the 'seventies. Windows with panes of this glass, which, in fact, allowed daylight of low intensity chiefly in the blue-violet to pass into rooms, were installed in the belief that it would have curative and tonic effects on persons or plants living in this magical twilight.

The color of the glass or screen is not an index of the rays which may pass through it. Thus one of the best media for transmitting the ultra-violet rays and shutting out the remainder of the spectrum is a glass as brownish-black as this ink, while another glass which cuts out heat rays, including some of the red rays of visible light, has a distinct greenish tinge.



THE ULTRA-VIOLET RADIOMETER

FIGURE 1—*In the box are the lenses and thermocouple. Above it is the driving motor; below it, the electrically operated escapement. The cable carries to the galvanometer in the laboratory below the minute currents generated in the thermocouple by ultra-violet rays sent out by the sun*

The eye is sensitive to wavelengths only as short as one sixty-five-thousandths of an inch, but it is to some of the rays of shorter wavelength which we can *not* see that attention is now being increasingly paid, as it is found that waves of not more than one seventy-five-thousandths of an inch in length exercise a curative effect for rickets, speed up the vitamines in fatty substances and tan the skin. These are the ultra-violet rays—or, more properly speaking, a part of them, for they do not have the same effect throughout their entire range of wavelengths.

NOW it is a matter of no little interest that these shorter wavelengths from the sun which just pass the screen of air surrounding the earth, and which can not be seen, are of very great importance to animals, especially man. These rays get down to the earth's surface only when the sun is not too far from the zenith or the air too hazy. Total deprivation of the effects of these rays may result in serious ailments, while proper exposures may have curative effects or promote growth, development or tone in

an organism, such as the human body.

Experimental analysis of the extent and character of the effects of these shorter wavelengths is now being carried on vigorously in half a hundred laboratories, and every month witnesses the appearance of contributions dealing with detailed or general effects of the ultra-violet rays on babies, rats, plants, protoplasm, food-substances or vitamines. It is not easy, therefore, to make a general statement which may hold in all features, even over the two months which must elapse before this article is to be published.

It may be safely ventured, however, that, beginning with the shortest waves which reach the earth from the sun, with a wavelength of 290 millimicrons, and ranging up to 320 millimicrons, the effect is to produce greater vigor, accelerate growth and heighten the action of certain vitamines. (A millimicron equals one millionth of a millimeter, or about one 250,000,000th of an inch. The wavelengths of several parts of the spectrum, expressed in millimicrons, are shown in Figure 5.)

THE results of some studies on the effects of short wavelengths on seeds, by Sheard and Higgins, made in the laboratory for experimental medicine of the Mayo Foundation, may be cited as illustrative of the use of mercury vapor-lamps as a source of rays. Rays from 320 to 390 millimicrons in length appeared to favor germination and growth, while rays from 270 to 320 retarded the processes. Both series of exposures were for periods of a few minutes.

As the physician who practices heliotherapy well knows, it is desirable to shield the patient from the more intense heating rays, and care must be exercised not to expose him to the rays beyond a certain time. This duration of time is determined chiefly by the intensity of the ultra-violet light, for these unseen rays in sunlight may by long-continued action exercise a destructive action on the fragile jellies of protoplasm in our bodies. In this very action, in fact, lies the sterilizing effect of sunlight in destroying bacteria and other minute unprotected organisms.

QUARTZ mercury-vapor lamps emit rays which are especially intense in regions of the far ultra-violet spectrum (Figure 5) between 200 and 280 millimicrons, and some of these rays exercise an especially rapid action on living matter and are consequently very efficacious in sterilization. In exposing the human skin to rays from lamps which emit ultra-violet rays the problem is to avoid the disintegrating effects of these shorter, sterilizing wavelengths. This is attempted by various screening devices.

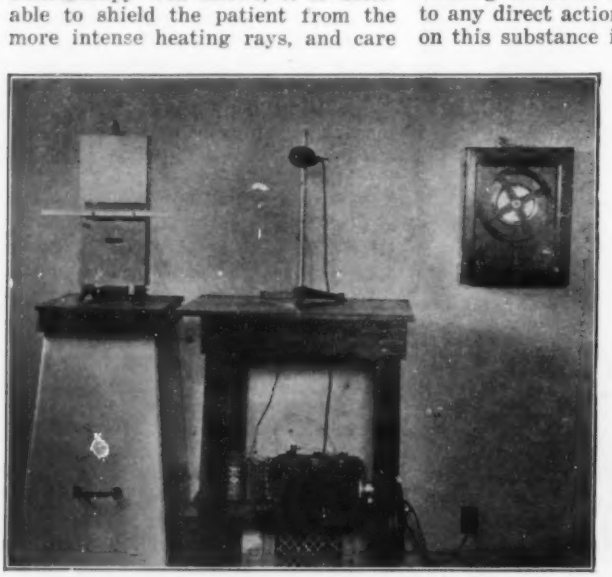
The action of ultra-violet on the constituents of fatty substances which are used in curing rickets is very notable. The vitaminic action is speeded up or accelerated by exposure to rays from quartz mercury-vapor lamps. Recently Dr. Hess and his colleagues have shown that this effect is due to changes in a component of the cholesterol included in cod-liver oil, under the action of rays from such a lamp. However, little progress has been made in the determination of the direct physical effects of ultra-violet rays on the surface of the human body. Our blood carries cholesterol through the tiny capillaries near the surface of the body, but nothing whatever may yet be said as to any direct action of the sun's rays on this substance in our bodies.

Progress in this field has been delayed by the complexity of the problem, lack of adequate technique and by the fact that practical methods of rapid, dependable measurements of the intensity of the ultra-violet component of the sun's rays have until recently not been possible to make.

As will be described below, records of the total intensity of the sun's rays, however accurately made, do not serve as an index of the ultra-violet in them, because fine dust in the air may screen out the short wavelengths; also because the relative intensity of these rays as emitted by the sun varies greatly from year to year. So much is this so, in fact, that a patient exposed to sunlight between 10 and 11 A.M., for example, in May, 1924, actually received less than two thirds the total exposure that he might have received in the same place and position in May, 1927.

DOBSON, of Oxford University, England, found that variations in the energy of the blue-violet sunlight transmitted through a silver film were found to show differences as great as 30 percent from day to day. This method was taken up by Pettit at the Solar Observatory at Pasadena. After some experimentation he designed an ultra-violet radiometer in which a daily record of the intensity of these short waves is traced on a photographic plate, in parallel with a tracing of the intensity of the green light of the sun at the same time.

As an instance of the short time in which the instruments and methods of so-called "pure research" may be put to direct use, this ultra-violet radiometer serves as a good example. Dr. Pettit began his studies in June, 1924; before the close of 1925 an in-

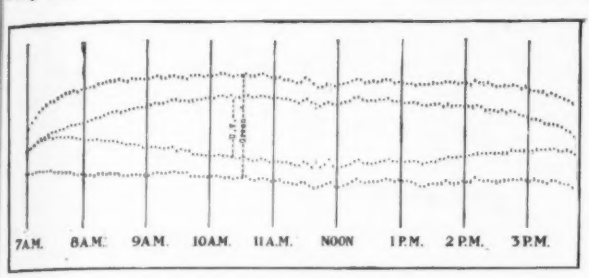


HOW THE VARIATIONS ARE MEASURED

FIGURE 2—*The contact clock (right), and the lamp (center) from which a beam of light falls on the galvanometer mirror and is reflected back to a screen and measuring scale on left*

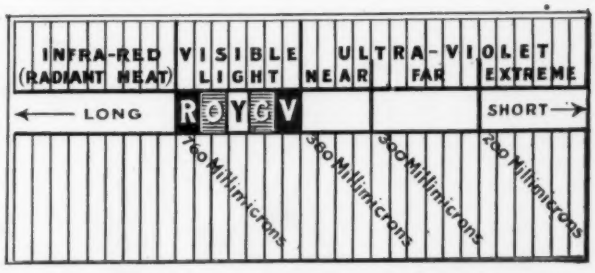
DR. EDISON PETTIT AND HIS RADIOMETER

FIGURE 3—*Dr. Pettit is a member of the staff of the Mt. Wilson Observatory. With his radiometer he has shown that the sun's ultra-violet radiation varies widely from day to day*



A DAY'S ULTRA-VIOLET RECORD

FIGURE 4—*This sample record covers the day of October 19, 1926. It shows respectively the amount of ultra-violet (inner two rows of dots) and green (outer rows of dots) radiation from the sun on that day. Each four minutes a dot is automatically made by the radiometer. In this particular record local apparent time at Tucson, Arizona, is indicated*



SIGNIFICANCE OF THE TERM "MILLIMICRON"

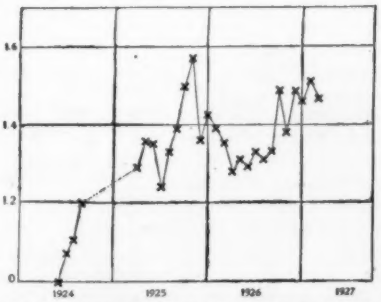
FIGURE 5—*The diagram is practically self explanatory. The letters in the center represent red, orange, yellow, and so on. Through familiarity, the physicist comes to associate various wavelength designations in millimicrons, or sometimes in Angstroms (tenths of a millimicron), with certain parts of the spectrum, a thing the tyro quickly picks up*

crease of 57 percent in the intensity of the ultra-violet had been measured. Some description of these results and of the radiometer by which they were measured was given verbally to the writer in December, 1925. A request for the construction of such an apparatus for the use of the newly founded Desert Sanatorium at Tucson was made in the same month. Construction was begun in February, contemporaneously with Dr. Pettit's publication of results, and a radiometer was installed a year later, as shown in Figure 1. In other words, the second model of a technical instrument for pure-science research in solar physics is already devoted to "applied" science. Naturally this second instrument possesses a perfection of design not in the original.

THE essential part of the ultra-violet radiometer consists of two quartz lenses and a small delicate thermocouple. The lenses are of one inch aperture, with a focal length of two inches, and are set in an air-tight cell behind thin quartz plates. Quartz is used instead of glass because it is transparent to the ultra-violet rays of the sun. The inner surface of the quartz plate and lens in one of the cells is covered by two dense coats of metallic silver of such thickness that all radiation except the ultra-violet, that is, radiant heat and visible light, is stopped; while the ultra-violet passes on through the quartz lens and is brought to a focus as a disk of ultra-violet light one fiftieth of an inch in diameter, on a thermocouple. The galvanometer connected with the thermocouple is deflected, and the deflection is recorded photographically on a glass plate. This gives a measure of the intensity of the ultra-violet light.

A second cell, mounted on the same disk as the first, contains a glass plate and a lens coated with gold. This metal, reversing the action of silver, does not allow the ultra-violet rays to pass, but it does transmit most of the visible rays.

The disk with the two cells is now rotated so that the thermocouple is acted on by ultra-violet rays for one minute, then by green rays for the next minute. By this method two lines of dots are made on the record. These show the relative intensity of the green and ultra-violet. Variations in intensity by four-minute intervals throughout the day in both the green and ultra-violet are thus made available. If the thermocouple is exposed to a standard lamp at intervals, the relative values of the green and ultra-violet may be reduced to absolute values. (Figure 4.)



HOW THE ULTRA-VIOLET VARIES

FIGURE 6—*March of the monthly mean value of the ultra-violet solar radiation in wavelength of 32 millimicrons during three years as measured on Mt. Wilson. A maximum was reached in the month of November, 1925*

The radiometer must be kept in continuous adjustment with the sun's apparent movement, and this is done by carrying it on an equatorial mounting such as might serve for a six-inch telescope, as shown in Figure 1.

That it may be advantageous to expose materials, living things and particularly human patients, to some types of radiation and not to others is now abundantly evident. In some operations the red, or heat rays, give the desired effects. At present, attention is being directed chiefly to exposures to the ultra-violet, without undue heating; that is, to the production of effects like sunburn in the dark.

Recognition and public interest in these facts has progressed far, and a well-known news service is authority for the statement that the *London Times* and other newspapers print a daily record of the intensity of the ultra-violet rays received on the city streets. It is now possible to purchase a pocket spectroscope with which the arrival of the ultra-violet rays in the morning may be detected, and their presence confirmed during the day.

Light-screens of various kinds are now available. Sheets of quartz allow all sunlight that reaches the earth's surface to pass into a room. But if a film of silver is laid on the quartz, visible light is stopped, although the ultra-violet is transmitted with near perfectness. A screen of this kind would be an ideal arrangement for the use of a physician for giving his patients ultra-violet treatment in heliotherapy, at the same time avoiding the heating rays. But its financial "temperature" would be high!

TODAY the development of formulae for making glass which will transmit ultra-violet with the least loss is the object of researches in more than one industrial organization. Some technical success has been achieved, one glass and other media are already in use in a New York hospital and in the Desert Sanatorium. Most of these substances also transmit some of the longer visible rays, which is not always a disadvantage.

Behind the dark-colored glass mentioned, and also behind a sheet of silvered quartz a sunburn in the dark or in an illumination no stronger than that of deep twilight may be possible. Crowded populations living or working indoors are deprived of sunlight and we are becoming aware that deficiencies result from it.

In getting back to natural daylight, some progress has been made in the study of differential effects of various wavelengths. Of these, the shortest which penetrate the atmosphere, and which are beyond the range of the eye, and certain other parts of the ultra-violet, are of very great importance for their curative effects and tonic influence.

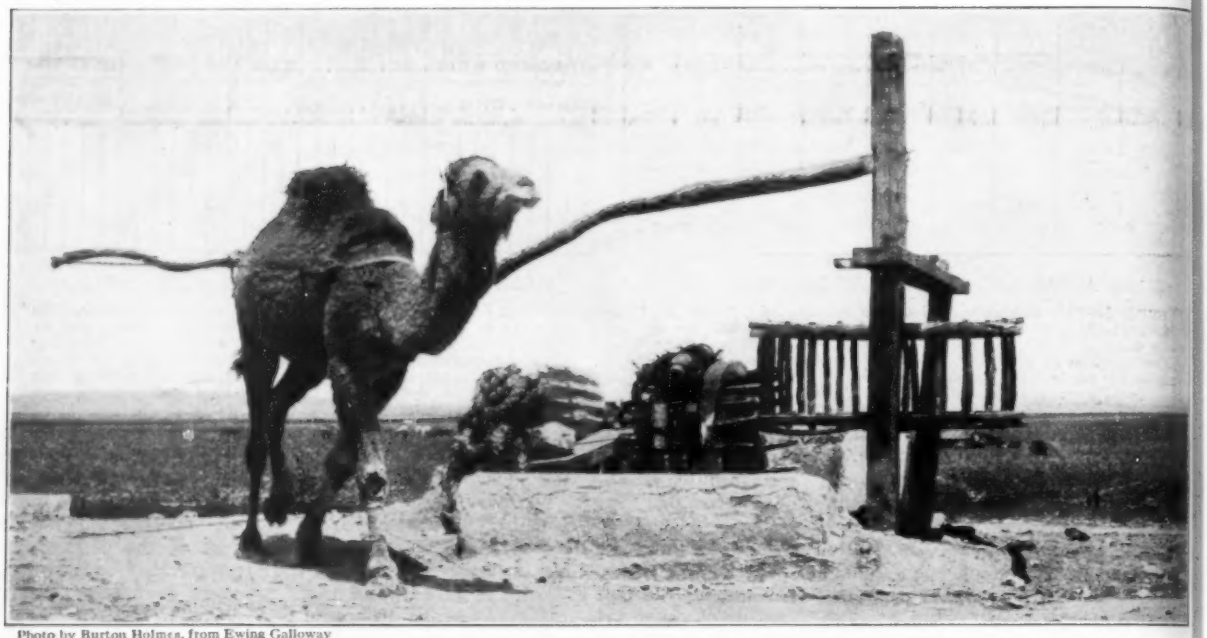


Photo by Burton Holmes, from Ewing Galloway

IRRIGATION WITH THE SAKIEH, OR CHAIN OF POTS, ALGERIA

In the arid southern Mediterranean lands thousands of dromedaries plod sleepily 'round and 'round such primitive pumps as this. The design has been changed but little in several millenia. A study of the efficiency of the gearing might prove interesting!

Photo by Burton Holmes, from Ewing Galloway

THE COMMON WHEEL, OR CAPSTAN, FOR IRRIGATION IN HUNGARY

Here there are two buckets and the horse reverses direction after each bucket of water has been raised. The empty descending bucket helps counterbalance the rising bucket. This is not so crude as it seems; its mechanical losses are not excessive

Primitive Irrigation Methods Still Compete With Modern Machinery

Because man-power in many countries may still be had so cheaply, ancient irrigation machinery still squeaks and creaks its inefficient way through a modern world. Some of the irrigation pumps shown on these pages are literally "as old as Moses." Just as civilization stands squarely on agriculture for its existence, so did agriculture itself first depend on the discovery of irrigation. "The discovery of the device of irrigation and the realization of its tremendous significance involved vastly greater issues than even the invention of so fundamentally important a practice as agriculture," says Prof. G. Elliot Smith in "The Ancient Egyptians." Irrigation, according to Prof. Smith, was first hit on in Egypt. Today, in that arid land the traveler may see in every

Photo by Barton Holmes, from Ewing Galloway

IRRIGATION IN SIAM, WITH THE SIMPLE DRAINAGE WHEEL PUMP

The workman (in this case a woman: the man is busy seeing that she does it right!) keeps the paddles turning by walking on a set of foot treadles. Thirty-foot wheels of this type, steam driven, have proved efficient in Louisiana, for drainage

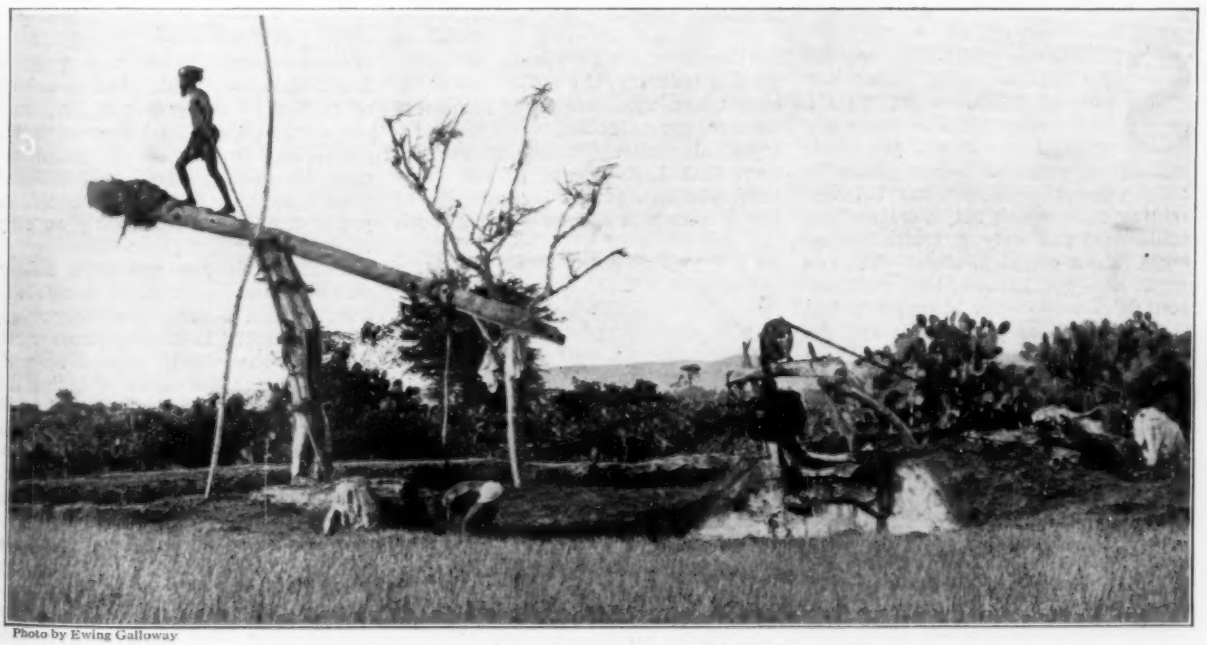


Photo by Ewing Galloway

WALKING WATER UPHILL WITH THE PICOTAH—INDIA

This is similar to the counterbalanced well sweep. Instead of pulling downward on the pole to elevate the counterweight, as in the Egyptian shadouf*—and in many an old-fashioned American farmyard—the workman's own body acts as counterweight*

field, irrigation pumps that are practically identical with those depicted on ancient engravings. In addition to the "chain of pots" illustrated on page 26, the *shadouf* is widely used in Egypt. The *shadouf* is simply the old-fashioned, counterbalanced well sweep: the workman pulls down on an upright pole, raising the counterweight. In descending, this raises the bucket. This equipment is remarkably efficient if time and labor are no object. Recently Dr. J. S. Haldane and Dr. Yandell Henderson published an analysis of the work performed by one workman irrigating with this form of apparatus. They found that a man in lifting a 60-pound bucket of water 6½ times a minute, did 4,290 foot-pounds of work per minute. From physiological data they reckon the efficiency of the entire unit—*shadouf* and workman—at about twenty percent. This is far above the mechanical efficiency of a boiler, engine and low-lift centrifugal pump such as would be used in a modern installation. Such comparisons are not, however, fair to machinery: it does some things a man cannot do.

All illustrations courtesy Commercial Solvents Corporation

HUGE PLANTS HAVE BEEN BUILT FOR BUTANOL MANUFACTURE

Growing demands for the solvents produced through the activities of a minute microbe form the basis of a flourishing industry. This is one of the Peoria, Illinois, plants that is so engaged

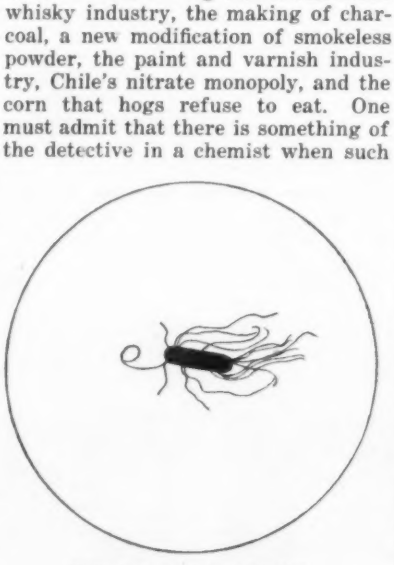
A Microbe in International Affairs

As a Detective, the Chemist Has Unearthed Processes of Vital Industrial Importance

By D. H. KILLEFFER
Associate Editor, *Industrial and Engineering Chemistry*

SHERLOCK HOLMES gained his reputation by using unnoticed trifles to build up a chain of evidence to manacle a wrongdoer. Indeed the whole system of criminal investigation is built upon the connections between trifling clues which only a trained eye could find and only a trained mind build into a complete story. Yet one need not go beyond the ordinary bounds of work-a-day business to find thrillers quite as picturesque and details quite as important as could be found in any detective romances. As Dr. Watson might have said to Sherlock Holmes, had he been interested, "That butanol case stirs my imagination. One might believe that so long a chain of circumstances had been entirely invented by a mere writer of fiction and had never existed in real life. Your deductions in that case, my dear Holmes, were perfectly marvelous."

Of course, Dr. Watson never said anything of the kind because the butanol business is a thriving reality and is not in any way to be connected with criminals. Yet the train of circumstances which led to the building of this industry and the many effects it has had in the world of business are far more like a romance than a serious history. As long ago as 1910 the threads of evidence began and ultimately they connected the British War Office, an odd micro-organism, a potential swimming pool, an early unsuccessful effort to make rubber, the demise of the legitimate American whisky industry, the making of charcoal, a new modification of smokeless powder, the paint and varnish industry, Chile's nitrate monopoly, and the corn that hogs refuse to eat. One must admit that there is something of the detective in a chemist when such apparently unconnected things can be worked together into the foundation of two great American industries.



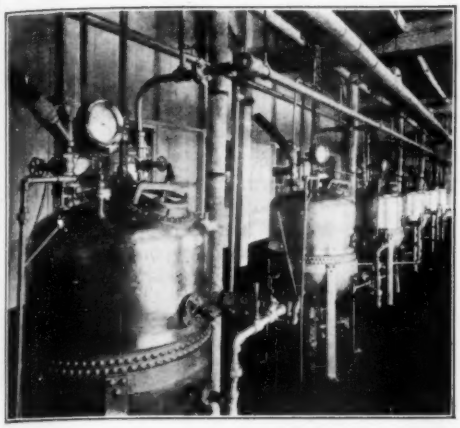
THE MICROBE ITSELF

The clostridium acetobutylicum (Weizmann), shown at 240 diameters, converts starch to solvents

To bring these apparently isolated circumstances into their proper mutual relations, it is necessary to go back to 1910, and before, when energetic efforts were being made to produce rubber without having to go to a tropical tree for it. A number of chemists working on this problem found that they could produce a kind of rubber by using certain very rare and costly chemical substances. These materials, isoprene and butadiene, could be made without great difficulty from butanol, a very near relative of grain alcohol but not nearly so easy to get.

The search for synthetic rubber was almost at the point of being abandoned when a tiny micro-organism, with a name, as usual, much more imposing than itself, turned up with every apparent intention of saving the day. The day has not yet been saved for synthetic rubber but the *clostridium acetobutylicum* (Weizmann) today is permitted to exercise its remarkable appetite for starch and its still more remarkable ability to convert it into acetone and butanol on a huge scale. Because this butanol was at that time interesting as a raw material for synthetic rubber, the habits and desires of this microbe were studied with minute care and ways were found to make it even more comfortable than a "bug in a rug" or a "contented cow." All of which having been duly determined was recorded with greatest care against future need.

The second circumstantial thread begins with a peculiar specification of the British War Office, that smokeless powder for the British armies be made with acetone as a component of the solvent used in its preparation. At the time that this specification was

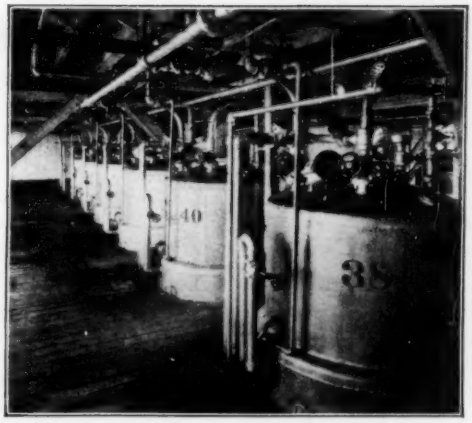


LEFT

Beginning with a dormant spore, the industrial operation consists in growing successive generations on starch solutions until active bacteria are obtained. After growing under careful surveillance, cultures are transferred to these 50-gallon aluminum kettles

RIGHT

Growth of the bacteria is carefully followed through six days on successively larger scales until the final brew from these thousand-gallon kettles is of proved purity, capable of satisfactory performance in the large-scale fermenters which follow



adopted, no such demand for powder as that of the World War was within the possibility of imagining, and the manufacture of charcoal from hard wood gave every promise of supplying any ordinary need for acetone. Of course, the war changed everyone's conceptions and the British Tommies were shooting away powder at so prodigious a rate that the forests of the world, and particularly those of Britain, might have ceased to exist had it been necessary to depend upon them alone to supply acetone. In this emergency, the British War Office was forced to turn to the microbe of the rubber makers to keep up the essential supply of acetone for its powder factories.

Perhaps no microbe ever enjoyed so essential a part in a war as this one did and every possible effort that time would permit was made to make its working conditions the most satisfactory that could be devised. In England, in India and in Canada, it undertook the task of converting huge quantities of potatoes, rice and corn into the much needed acetone. Neither the War Office nor anyone else was at that time interested in the fact that more butanol was made in the process than acetone, for everyone was too busy doing his part in winning the war, or at least in preparing to tell the world how essential he had been, to worry about the not very pressing problem of rubber synthesis. Later, after our entrance into the conflict, an erstwhile whisky distillery in the Indiana corn belt was converted into a plant for the manufacture of acetone under the joint control of the American and British governments. With this converted distillery, the story might properly begin, for it has served as the foundation on which a new American industry has been built.

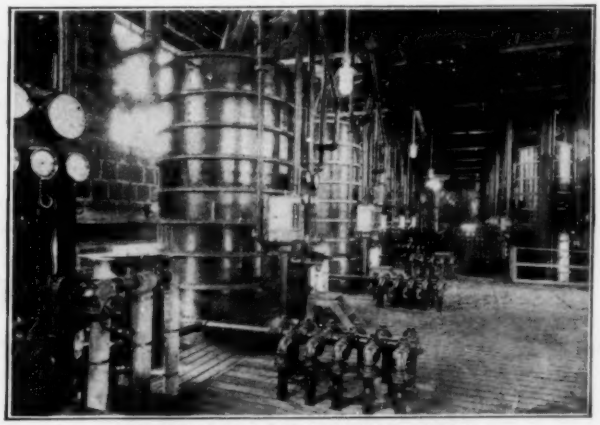
THE whisky industry in the United States had always centered around the sources of corn in Indiana and Illinois and had performed the task of converting edible and waste corn, which could not be used for anything else, into a marketable product. When the food administration curtailed the use of corn for this purpose, it was necessary not only to find something to do with the distillery itself but also to find a way to use up mouldy, waste corn. Under these circumstances our microbe was put actively to work producing in this old distillery great quantities of acetone, which was in urgent demand as a solvent for nitrocellulose, to be made into smokeless powder for the British and into airplane dope for the Americans.

Disguises must have a part in every detective romance, and in this particular one a deep disguise covered the blessing in the operation of this old distillery. Every time a pound of acetone was made, the microbe insisted upon accompanying it with two pounds of butanol, and although everyone wanted acetone, no one was at all interested in butanol. A little of it was used but the vast amount which had to be made was not only quite useless but to dispose of it was very troublesome. It would not burn satisfactorily and the fish in the rivers refused to accept it as part of their watery habitat. In this quandary the operators of the plant decided to save it by building immense vats in which to keep it against future need. One of these vats now serves as an admirable swimming pool and it is on this swimming pool filled with its unwanted contents that one leg of the American lacquer industry rests. This bit of economy was most fortunate, despite the cost of the vats.

The disguise was torn from the face of butanol when some chemists who had been much interested in

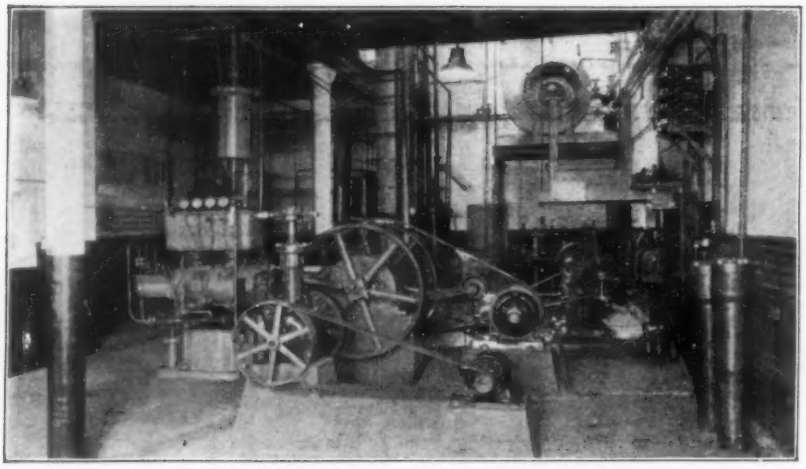
FIFTY-THOUSAND-GALLON FERMENTERS

The microbe gets seriously to work in great fermenters, each as large as a small-town water tower



FRACTIONATING COLUMN STILLS

Here the water is removed from the solvents produced, and the latter are separated by distillation



EXPERIMENTAL GAS UTILIZATION PLANT

Methods of utilizing the hydrogen-carbon dioxide mixture from the fermenters are studied here. An ammonia synthesis plant is already operating as a result of research

smokeless powder discovered a method of making nitro-cellulose which would yield a solution thin enough to spread and thick enough to cover, as a varnish covers, the object to which it is applied. It was this kind of nitrated cotton which made possible our present-day industry in nitro-cellulose lacquers and it was this swimming pool full of butanol that furnished butyl acetate to serve as the essential solvent. It is somewhat doubtful if capital could have been persuaded to go into the large-scale manufacture of butanol which this new industry required without the benefit of the compelling proof of its fitness which this surplus furnished.

THESE two things, cheap butanol and low-viscosity cotton, are the foundations of the lacquer industry, whose phenomenal growth is among the most amazing of modern industrial wonders. Little more than three years ago, nitro-cellulose lacquers had been used only in small quantities as a protection of metal surfaces and for airplane wings, whereas today the department stores offer a dozen different varieties in dozens of colors and shades for household use and there are few automobiles made whose finish is not a lacquer. The quantities of lacquer used are increasing at a prodigious rate and, concurrently, the output of butanol has had to grow to supply the necessary solvent. Within the past 18 months, the butanol output has been more than doubled—it is now 60 tons per day—and a still further increase of an approximately equal amount is expected within another year.

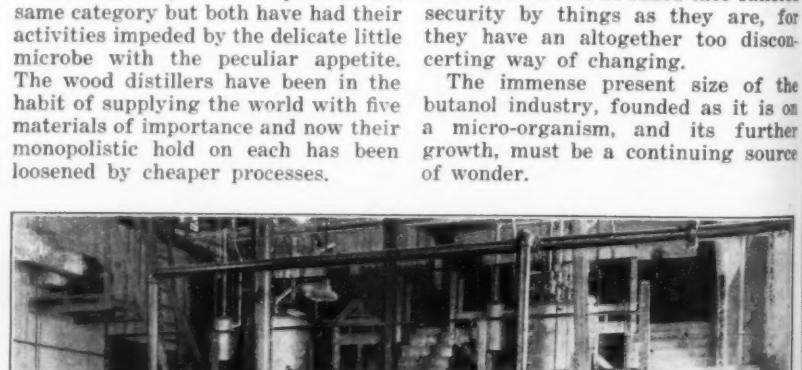
The effect of the lacquer, made from butanol, on the paint and varnish industry has been serious, but the wood distillers, already under an accumulation of difficulties, have found it hard to survive the manufacture and sale of the huge quantities of acetone produced as a by-product of this operation. The activities of the microbe result in the production of butanol (normal butyl alcohol), acetone, and ethanol (ethyl alcohol) in the ratio of 6:3:1, and thus the present unavoidable output of acetone amounts to some 30 tons per day. This must be absorbed by industry, and since no corresponding increase in use has been developed, it has operated to control acetone prices, acetone having formerly been one of the main dependences of the wood distillers for a profit from their operations.

The wood distillers and the Chilean nitrate industry are not quite in the same category but both have had their activities impeded by the delicate little microbe with the peculiar appetite. The wood distillers have been in the habit of supplying the world with five materials of importance and now their monopolistic hold on each has been loosened by cheaper processes.

The Chilean nitrate industry has long exercised a monopoly in supplying the world's farms with nitrogen for fertilizers, but in recent years synthetic ammonia has become a formidable competitor. Now, the synthesis of ammonia requires nitrogen to be had gratis, or nearly so, from the air, and hydrogen, which is expensive. When our peculiar *clostridium* is comfortably converting starch into butanol and acetone, it breathes out great quantities of hydrogen, mixed with carbon dioxide from which it is easily separated, and so the latest effect of the microbe was the use of this hydrogen to make ammonia. Of course, the quantity produced by the microbe's help is not enormous, but every little bit added to the world's increasing output of synthetic ammonia sends a new shiver down Chile's back.

THE shift of emphasis from butanol, desired by the rubber synthesists to acetone, important during the war, and now back to butanol, a fundamental raw material for a new and very important industry, is characteristic of the kaleidoscopic changes constantly occurring in the rapid development of chemical industry. A useless by-product, expensive to dispose of today, often becomes overnight the valuable part of one's output. The changing face of affairs under such circumstances can only be met by continuous, energetic research. New ideas come so rapidly to an intensively thoughtful industry that no one can afford to be lulled into fancied security by things as they are, for they have an altogether too disconcerting way of changing.

The immense present size of the butanol industry, founded as it is on a micro-organism, and its further growth, must be a continuing source of wonder.



FERMENTATION PILOT PLANT

Many suggestions for improving yields in the large plant units are sent to this pilot plant for trial before adoption, to prevent needlessly upsetting commercial operations

Successful Inventors---VII

A Pioneer in the Telephone Art Gives Some Excellent Advice

By MILTON WRIGHT

"IN the field of invention the outsider often has better prospects of success than the man on the inside of a particular industry. I am assuming, of course, that the outside inventor has a fund of fundamental knowledge.

"Men who are too closely identified with a particular line of industry—who are working at it every day and possess all the existing knowledge there is about it—are likely to be too much concerned with details. A new idea does not occur to them when it is out of line with all the theories they have been working on. That scheme is branded as impracticable because it flies in the face of all the principles they have studied. In other words, they 'can't see the forest for the trees.'

"Also, the inventor who would be successful must not be burdened with too many facilities. When a man's resources are meagre he has to exert himself as the man with plenty of resources at his command never has to do. He has to stretch his imagination and his ingenuity to make up for the equipment he lacks. And because he works harder, he works more resultfully."

IT was Emile Berliner speaking—Berliner, the inventor of the microphone, the electrical transformer and the gramophone. His were the inventions which made the telephone practical. His was the invention upon which the Victor Talking Machine Company was founded. In the record of invention his name is carved deep. If ever an inventor's experience might serve as inspiration to inventors whose feet are still on the first rungs of the ladder, it is that of Emile Berliner.

"I am indeed glad to see a representative of the SCIENTIFIC AMERICAN," he said when we visited him in his office in Washington, in the building he has erected for administering the child welfare work in the District of Columbia, to which he now gives most of his time and energy. "Your magazine was a great help to me when I was preparing for a career as an inventor."

"How long ago was that, Mr. Berliner?"

"That was back in 1874. I read it as part of my scientific education when I was attending Cooper Union in New York. With the hankering I had for scientific things, I read all the scientific literature I could lay my hands on."

"What started you on your first invention—the magneto telephone?" we asked. "Was it through coming in contact with people working along the same lines?"

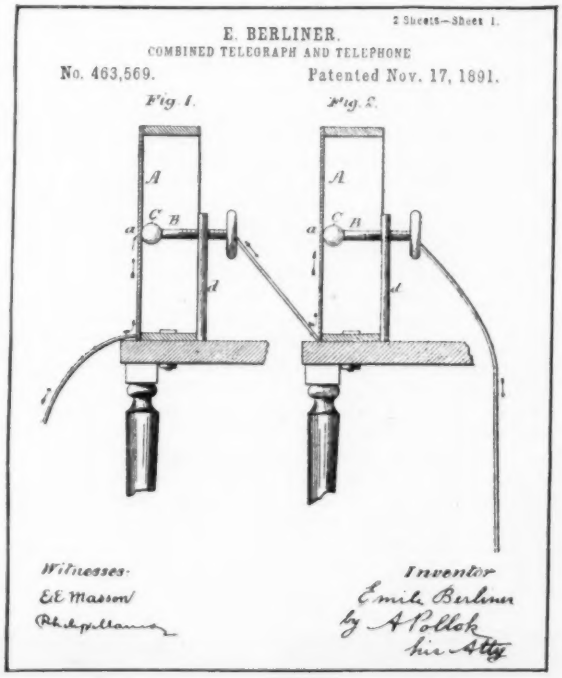
"As a matter of fact, I had never seen Bell's telephone when I started to work to make a transmitter in 1877," he replied. "But the telephone was being talked about. Bell had demonstrated it at the Centennial Exposition in 1876 and it was looked upon as one of the wonders of the age. I was clerking in a Washington dry-goods store, but I put in all my spare time experimenting with a telephone of my own contrivance.

"It is strange what little things will serve as a clue when you are groping for a new idea. One of the men I used to visit occasionally in those days was Alvan S. Richards, chief operator at the Washington fire-alarm telegraph office. I told him one day that I was learning to transmit messages.

"'Let me hear what you can do,' he said, pointing to a sending instrument not being used. I placed my finger on the key and started.

"'Hold on,' he exclaimed, 'that isn't right, you must press down on the key, not simply touch it. There must be a firm contact or your message may not be understood at the other end.' He went on to explain that in long-distance transmission, where the resistance is high, more current passes through the contacts when more pressure is used on the key.

"With that explanation I knew I had what I had been seeking. I went home, rigged up a diaphragm and made a contact with a steel button. I began to adjust it until the galvanometer showed that current was flowing. Then I pressed gently and I found that each time I pressed, the galvanometer deflected through a larger angle."



ONE OF BERLINER'S FIRST PATENTS

This covers the type of transmitter in which variations of pressure between two contacts vary the current flow

THUS Berliner hit upon the idea of the microphone. Hitherto the invariable rule with electromagnets was firm contacts. Discarding the old make-and-break principle, he converted a continuous electric current of any strength into waves, corresponding to sound waves with all their delicate variations, instead of letting the force of the voice produce a weak electric current as Bell was doing.

On April 14, 1877, he filed a caveat on his invention in the Patent Office, drawing up the document himself. Such a document—caveats were abolished several years ago—was a description of an invention filed in the Patent Office before the patent application was filed. Its purpose was to get an invention on record, in order to establish priority while the inventor was still working away on the details. In June he filed a regular application and in October of the same year Berliner filed his application for the continuous-current transformer.

"How did you commercialize your telephone inventions?" we asked.

"I got in touch with the Telephone Company of New York, a subsidiary of the then struggling Bell Company," he said, "and offered to sell my inventions. They turned down my offer

but invited me to go to New York and demonstrate what I had. One demonstration led to another, until Bell's associate, Thomas A. Watson, at a visit to me in Washington, said, 'We will want that, Mr. Berliner. You will hear from us in a few days.' Later I signed an agreement to turn over my caveats and patent applications, as well as the use of my induction coil or transformer patent. I received a modest salary and a royalty on all transmitters to be exported. Several years later the Bell Company paid me a lump sum and greatly increased my annual retainer. This took the place of salary, because I later went to work for myself."

"What do you consider the best time for an inventor to capitalize his invention—after he gets his patent or before?"

"After you perfect your invention, apply for a patent. As soon as you get a favorable action in the Patent Office, go to some big concern which would be interested, and lay your invention before the chief engineer. He will either tell you why, in his opinion, it will not work, or he will make you an offer. This is substantially the method I adopted and I think it is the logical one."

"BUT cannot better results sometimes be obtained by an inventor organizing his own company and selling articles covered by his patent?"

"Oh, yes. That is the method I pursued after I invented the lateral-cut disk gramophone record. There was keen competition. The American Graphophone Company had established a factory and was producing the Bell-Tainter graphophones and wax-covered paper-cylinder records. Edison, too, had invented his improved phonograph. It appeared to be practically the same apparatus as the graphophone, differing only in form and motive power.

FIRST BERLINER TRANSMITTER

This original model of the loose-contact microphone is now in the Smithsonian Institution at Washington, D. C.

"When you have something radically different from anything everybody else has—when you can accomplish something nobody else can accomplish—your prospects of making a commercial success are bright. What I succeeded in doing in the little laboratory in Washington which I opened up after I left the Telephone Company, was to 'etch the human voice.' By devising a disk gramophone record and working out a means of cutting it laterally at an even depth, I could get accuracy and purity of tone impossible with the cylinder records with their up-and-down cuts of uneven depth. More than that, however, I solved the problem of making unlimited copies of one original record.

"The tremendous commercial success of the talking machine is, of course, due in some measure to the genius of Eldridge R. Johnson, president of the Victor Talking Machine Company, who covered both technical and business fields. My part in it you may gather from the statement issued by the Victor Company several years ago as a warning to infringers."

We read this statement. It said:

"The manufacture and sale of the gramophone was first conducted by the United States Gramophone Company, followed by the Berliner Gramophone Company, and then by the Victor Talking Machine Company, which latter company acquired its rights from the former companies.

"We now control the original Berliner basic patents, and we have the gramophone developed to its present condition. Through our efforts and improvements, the gramophone has become an important factor in the market, in spite of the general opinion among talking-machine manufacturers, at the time of its advent, that it was destined to remain nothing more than a toy."

MINDFUL of the fact that Berliner's first inventions — those relating to the telephone—were made when he was 25 years old, and his next—those relating to the talking machine—when he was 36, we asked:

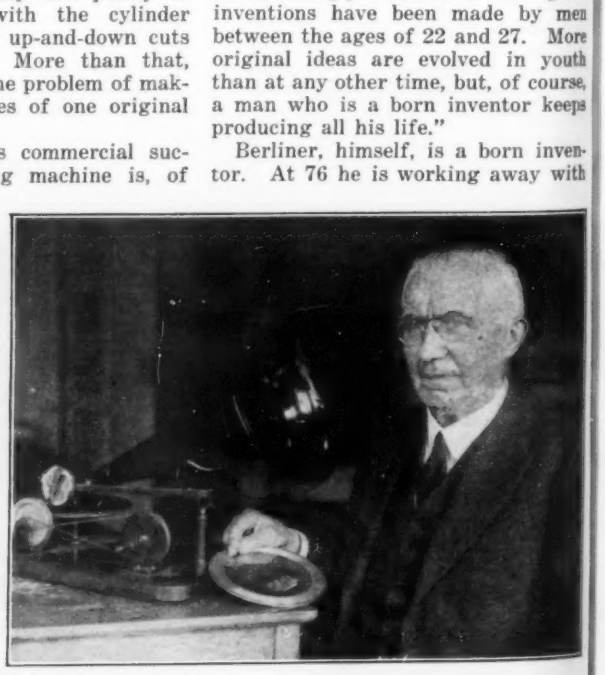
"When would you say an inventor is most productive—in youth or in later years when he has acquired a fund of knowledge and experience upon which to build?"

"The young man is the most prolific inventor every time," he replied unhesitatingly. "Most of the great inventions have been made by men between the ages of 22 and 27. More original ideas are evolved in youth than at any other time, but, of course, a man who is a born inventor keeps producing all his life."

Berliner, himself, is a born inventor. At 76 he is working away with

EVOLUTION OF THE GRAMOPHONE

These models of gramophones and the records used with them are exhibited in the National Museum, in Washington, D. C.



Underwood and Underwood

FIRST COMMERCIAL GRAMOPHONE

Mr. Berliner is shown here with one of his first instruments. He holds a matrix from which many records may be made

©Harris and Ewing

DEMONSTRATING ACOUSTIC TILE

A section of the wall in this photograph is covered with the tiles which are used to obtain good acoustics in auditoriums

©International Newsreel

MANUFACTURING ACOUSTIC TILE

They are built up on a base of wire screen. When finished, properly placed and covered, they act as vibrating diaphragms

all the enthusiasm of youth upon another invention just as revolutionary in the field of acoustics as any he perfected in days gone by. And it promises to be just as successful.

"What is the principle of this acoustic tile of yours?" we asked.

"Usually when an auditorium is treated for defective acoustics," he explained, "the walls are covered with some porous, sound-absorbing material, such as felt. This reduces the volume of all the bad sound, as well as the sounds you want to hear.

"On the other hand, wooden walls, especially pine or spruce, are ideal for auditoriums. They vibrate freely. Two of the best auditoriums I know of are the Mormon Tabernacle in Salt Lake City and the Wagner Theater in Beyreuth, Germany; the walls in both of them are of wood. It is logical to conclude that the cause of bad acoustics is the hardness or rigidity of the usual stone or concrete walls.

"MY remedy for bad acoustics is a process of covering a sufficient portion of the walls with a cement which combines the hardness and dignified appearance of a stone wall with the resonance of wooden panels. Such a cement I obtain, first, by mixing a porous material like asbestos, sawdust or pumice with ordinary cement, and then so shaping the tiles made from this mixture that, when joined to the wall, they form vibratory diaphragms. Here is the foundation of such a tile." He handed us a circular piece of wire netting laid over some sheets of coarse paper, about the size of a pie plate, but slightly convex. These are to be fastened to a wall, one beside another with the bulge out. The acoustic cement is then spread over the surface.

To get an idea of the effect of acoustic tile we went to the James H. Oyster School where Berliner had treated the walls of the auditorium, notorious for its bad acoustics. The inventor took a tuning fork from his pocket, struck it on a radiator and set it against the brick wall. A dull sound resulted, hardly louder than the tuning fork gave when vibrating out of contact with anything. He struck the tuning fork again. This time he set it against a handsome cement panel containing his acoustic cells. Instantly a deep, loud, sweet tone responded.

"This is only a small auditorium," he said, "seating about 600. The acoustics have been so bad, however, with such echoes and distortions that nobody could understand anything. Now anyone in the back row can hear perfectly the recitation of a six-year-old youngster on the platform. About one quarter of the wall surface is treated—that is all that is necessary."

Back at the Health Center where Mr. Berliner has his office, we had another demonstration. Down in the basement, which he has fitted up as a billiard room, he has lined the walls with acoustic tile. The floor is of wood, as is the floor in the hall leading into the room.

THE SOAP-BOX TRANSMITTER

This model of the loose-contact microphone is on display in the National Museum at Washington, D. C.

"LISTEN to your footfalls as you enter the room," said Mr. Berliner. We did. The moment we crossed the threshold the sound of our steps become louder and deeper, although our tread was no heavier. The acoustic tiles were responsible for the change. While we were with him, he received an acceptance of his offer to apply his acoustic cement cells in the trading hall of the New York Cotton Exchange.

A few days after we left Mr. Berliner, he informed us that he had just finished the large "Board Room" of the District Commissioners of Washington, which has suffered from bad acoustics for many years. Today that hall, which is 85 feet by 27 feet and 18 feet high to a vaulted ceiling, is so perfect acoustically that two people can carry on a conversation in an ordinary tone of voice from end to end.

"What would you say, Mr. Berliner, are the qualities necessary for an inventor?" we asked before we ended our visit with him.

"To be an inventor," he replied, "a man must be a keen observer. He should have unlimited patience, and hundreds of failures must mean nothing to him."

"But how about marketing the invention? Does it not take as much real ability to make a financial success as it does to produce the invention?"

"After you have made something really worth while, success is bound to come. Manufacturers in every line always are eager for new inventions."

Wide World

WOODROW WILSON BROADCAST ONLY ONCE

He is here shown leaving his home, in which microphones were installed for picking up his first and last radio address

Wide World

PRESIDENT COOLIDGE AT ARLINGTON

Through three microphones, the voice currents were distributed to a network of transmitters throughout the country

When the President Broadcasts

Harding Was the First Chief Executive Heard on the Radio—Coolidge establishes a record

ORRIN E. DUNLAP, Jr.

FOUR years have passed since Warren G. Harding faced the microphone on June 21, 1923, in St. Louis, to deliver an address on the World Court, thus establishing a record as the first President of the United States to be heard by radio. Many will recall how his opening greeting, "My countrymen all," and his frequent reference to the "wide open spaces" of the west, sent through the ether from the lone transmitter of WEAF, afforded the public in the Metropolitan district their first opportunity to tune in the voice of a President.

"I SHALL not attempt to coerce the Senate of the United States," said Mr. Harding. "I shall make no demand upon the people. I shall not try to impose my will upon anybody or any body. I shall embark upon no crusades. . . . May our vision never be clouded by specters of disaster or shadows of dismay! If, in our search for everlasting peace, we but let lead and follow humbly but dauntlessly the 'kindly light' of divine inspiration to all human brotherhood, gleaming like a star in the heavens from the most beautiful of all hymns ever written, 'God will not let us fail.'"

Several weeks later, on August 2, 1923, President Harding died in San Francisco.

The utmost interest was manifest over another broadcast on November 10, 1923, when it was announced that ex-President Woodrow Wilson, whose voice the public had never heard over the radio, was scheduled to speak through a trio of stations, namely, WEAF, New York; WCAP, Washington, and WJAR, Providence. Thousands of auditors, including President Calvin Coolidge, listened in, because it was reported that the great proponent of the League of Nations Covenant and the man most responsible for the armistice would give his views on subjects suggested by the recurrence of Armistice Day and by its significance.

FIRST PRESIDENT TO BROADCAST

Warren G. Harding, delivering his first radio address in St. Louis in June, 1923

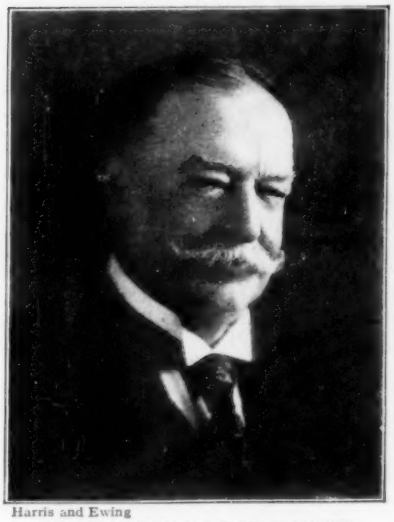
Radio impresarios, aware that this would be an historic occasion, because of the multitudes anxious to hear the voice of the wartime President, whose health had been wrecked, took every precaution to avoid interference. There was a common understanding between many of the important stations, not participating in the transmission of the Wilson speech, that they should sign off while Mr. Wilson was on the air.

THE Chesapeake and Potomac Telephone Company sent representatives to the Wilson residence on S Street in Washington with a specially equipped truck to which was attached the devices used in forwarding the voice over the telephone lines to the transmitters. The truck was stationed in the driveway beside the house and a trunk line was extended from the truck into the library on the second floor where the microphone was located. The amplifiers and other paraphernalia were on the truck where an engineer was on duty to regulate the amplification of Mr. Wilson's voice. From the motor car, the message was conveyed by an underground wire to WCAP and forwarded to the two other broadcasters.

The Washington announcer came on the air at 8:28 P. M., opening the circuit which switched in the microphone. Thus was opened the broadcasting system which was destined to send Woodrow Wilson's first public speech, addressed directly to the nation, since his collapse during the Peace Treaty ratification fight. Three minutes elapsed and the voice of the ex-President, a trifle husky at first but growing better as he proceeded, was heard by the radio audience in what proved to be the first and last radio address by Woodrow Wilson, who passed away on February 3, 1924.

Speaking to auditors throughout the east, the former President declared that the attitude of this country since the World War had been "deeply ignoble," "cowardly and dishonorable." He said that we had withdrawn from the affairs of the world "in sullen and selfish isolation," after our soldiers aided in winning the "war for right" and that the happy memories of those "never-to-be-forgotten days in November" of 1918 were "forever marred and embittered" for us by refusing to "bear any responsible part in the administrations of peace and establishment of the rights won by the war."

SINCE that occasion, President Coolidge has made good use of radio and has saved much time and effort by addressing the people through the microphone instead of taking long and tiresome train trips in order to speak to them. The Coolidge inauguration on March 4, 1925, will go down in history as the first ceremony of its kind to be broadcast. On that occasion, 27 stations from coast to coast were connected to the battery of microphones in front of the Capitol.



Harris and Ewing

HE BROADCAST FROM YALE

Ex-President Taft was heard on the air when he administered the oath of office to President Coolidge on March 4, 1925. His first radio address was radiated on April 20, 1927, when he spoke before a large audience in the Yale Club at Washington, D. C.

This record tie-up of transmitters was surpassed on February 22, 1927, when President Coolidge addressed a joint session of Congress assembled to pay tribute to George Washington, through a network of 42 broadcasters scattered across the nation from Portland, Maine, to San Francisco, California, reaching an audience estimated to be 20,000,000. So was formed a vivid contrast of the present time with the days when Washington's chief contact with the people was through small newspapers and letters to the leaders in each state.

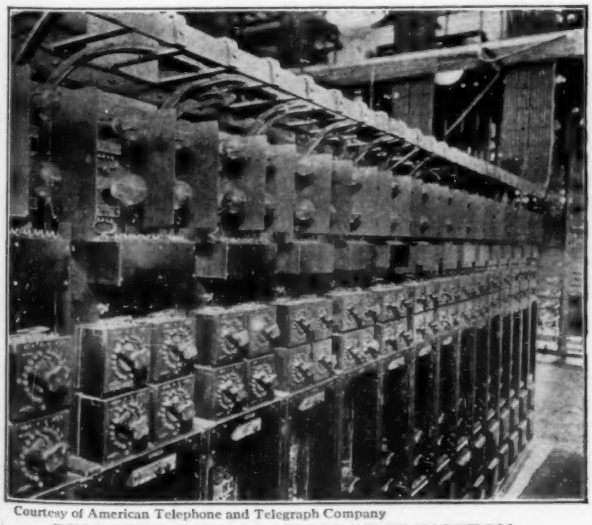
In addition to the regular broadcast, transmitters at WGY and KDKA sent the President's voice into space on short wavelengths which were detected in London, Paris and South Africa. The British Broadcasting Corporation rebroadcast the American waves from station 2LO so that listeners throughout the British Isles heard the President and the playing of "The Star-Spangled Banner" by the United States Army band, despite occasional interference and fading.

SIXTY Americans listened at the Savoy Hotel. They tuned in on the speech on eight-tube sets installed in their suites, and the last 15 minutes of the speech was broadcast through loudspeakers to 50 Americans who were dancing in the hotels.

"I had left my set turned on," said one American, "and was just coming down the corridor to the room when I heard the President's voice through the open door, yards away. It was so good that I could visualize him speaking."

The special wire circuits used to link the stations on this occasion covered approximately 10,000 miles and required the attention of 200 telephone engineers—two men at each of 53 repeater points and 37 terminal points and 20 at the central office at 24 Walker Street, New York City, the nucleus of the network. In addition, more than 200 radio engineers were on duty, since five or more men were occupied with the transmission of the program at each of the 42 stations. In this manner, chain broadcasting achieved a new record, while enabling President Coolidge to speak to the people of the United States in honor of the 200th anniversary of George Washington's birth.

The circuits utilized for connecting the broadcasters for simultaneous



Courtesy of American Telephone and Telegraph Company

REPEATER INSTALLATION AT PRINCETON

These repeaters or amplifying relays are located at various points along the radio wire network, so as to maintain the signal strength delivered to the various stations

Herbert Photo

SWITCHBOARD AT CENTRAL STATION

The operators at WEAF's speech-input control board, control volume and route the voice currents over the network's land lines, thus insuring proper transmission from all points

transmission consist of telephone lines especially adapted for the purpose. While the ordinary long-distance telephone wires may carry at the same time four or five telephone messages and numerous telegraphic communications, a "special circuit" for radio broadcasting must be cleared of all other traffic. Also, the broadcast circuits must be equipped with special vacuum-tube repeaters or amplifiers, since the ordinary repeaters used in long-distance telephone work are not designed to cover at one time the wide range of frequencies that are involved in the broadcasting of music and of speech.

IN addition to the telephone circuits over which the program is transported, another line paralleling the first is employed to keep all stations in the network in constant communication with each other by telegraph. In this manner, the condition of the various circuits is checked at regular intervals to make sure that every word or every musical note of the program is reaching all stations in the system with good intensity and free of extraneous noises.

The detailed routing of the President's address and other events of national importance begins with six circuits which leave the telephone headquarters at 24 Walker Street, New York City, in different directions. New England stations are supplied through two circuits, one traveling direct to Springfield, Massachusetts, to WBZ; the other passing through Hartford, Connecticut, where WTIC is located, then on to Boston, where WEEI is supplied, and to Portland, Maine, where the program is fed to the transmitter of WCSH. Taps at Hartford connect with WTAG at Worcester, Massachusetts, and with WJAR at Providence, Rhode Island.

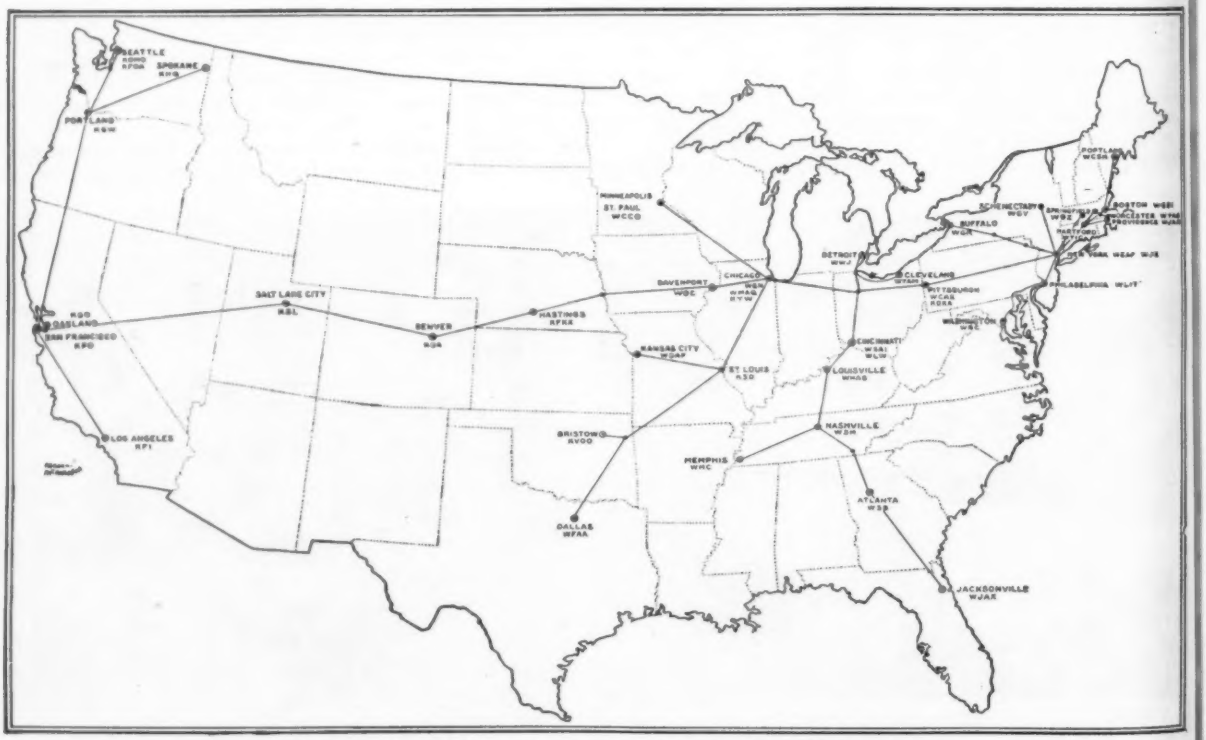
The third main line from New York carries the program to WGY, Schenectady, and the fourth passing through Scranton, Pennsylvania, and Elmira, New York, leads to WGR at Buffalo. Still another circuit parallels the incoming wire from Washington, running through Philadelphia, where it supplies either WFI or WLIT and then continues to Washington to feed WRC.

The sixth main circuit from New York travels west to Brushton, Pennsylvania, where a tap emanates to KDKA and WCAE in Pittsburgh, and passes on to Beaver Dam, Ohio. From this point a connecting circuit extends north through Maumee, Ohio, where a tap supplies WTAM at Cleveland and then goes on to WWJ at Detroit. Traveling south to Beaver Dam, another line runs through Cincinnati, Ohio, (WSAI); Louisville, Kentucky, (WHAS); Nashville, Tennessee, (WSM); Memphis, Tennessee, (WMC), and so on through Chattanooga to Atlanta, Georgia, (WSB), and Jacksonville, Florida, (WJAX).

Beaver Dam is connected also by special circuits with Morrell Par Illinois, located near Chicago, a from that point the transmitters WGN, WEBH, WMAQ and KYW a fed. A circuit running north fr Morrell Park connects with WCCO Minneapolis, Minnesota, and anoth traveling south reaches St. Lou Missouri, (KSD); then to Kans City, Missouri, (WDAF); Bristo Oklahoma, (KVOO), and Dall Texas, (WFAA).

WEST from Beaver Dam, WO at Davenport, Iowa, is su plied by a circuit which continues through Omaha, Nebraska, to Has ings, Nebraska, (KFKX); Denve Colorado, (KOA); Salt Lake Cit Utah, (KSL), and then on to Sa Francisco, where KPO is supplie with the program. Station KGO, Oa land, California, is fed direct fro San Francisco by a special lin Another channel passes south t Los Angeles (KFI), and anothe extends north to Portland, Oregon (KGW), from which point a ta emanates to Spokane, Washington (KHQ). Then continuing north fro Portland through Tacoma, Washington, wires connect with KOMO an KFOA in Seattle.

Thus, a broadcast event originatin in the east is spread across the continent; the Capitol is linked with th nation and the voice of the Presiden is within reach of an internationa audience.



HOW PRESIDENT COOLIDGE'S ADDRESS WAS BROADCAST

The solid lines show the routes of the wires that carried the voice currents on February 22, 1927. Forty-two stations were included

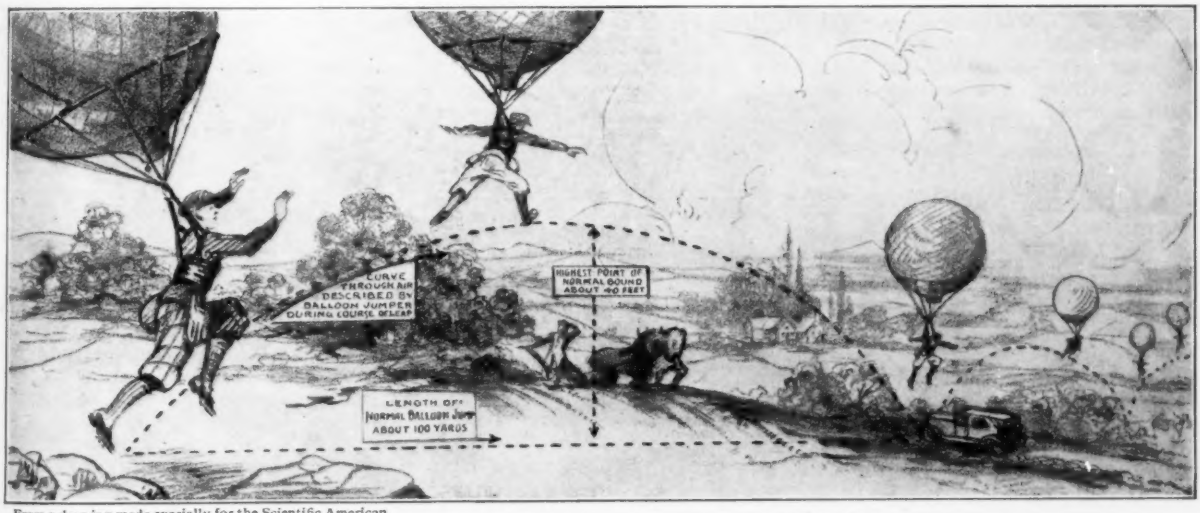
Photographs by P and A

PREPARING FOR A JUMP

The "jumping balloonist" is adjusting his ballast and harness before venturing to leave the ground in an initial jump

OVER AN AUTOMOBILE

Here the balloonist is demonstrating his ability to clear obstacles. A single bound carried him over an automobile



From a drawing made specially for the Scientific American

CROSS-COUNTRY JUMPING WITH SMALL BALLOONS

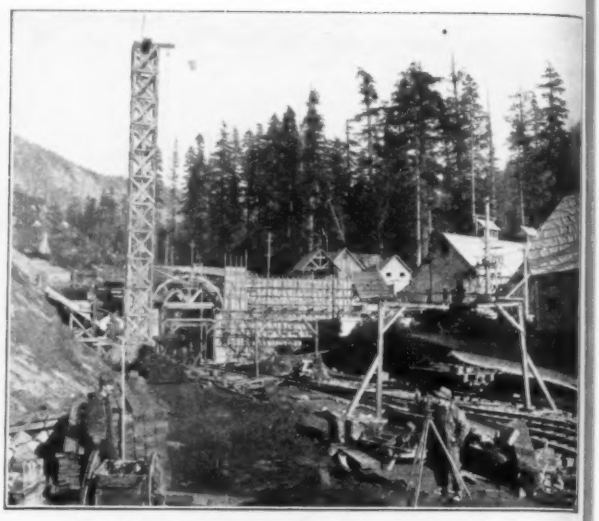
Our artist has here shown the possibilities of the new sport of balloon jumping. At a single bound, it is possible to cover a distance of 100 yards or more, when unhindered by wind. An ordinarily strong jump will send the jumper 40 feet into the air

Small Balloons Provide New Sport

Using a balloon having a capacity of about 3500 cubic feet, and equipped with the proper harness, it has been found possible to make enormous jumps with no motive power other than that of the jumper's muscles and any slight breeze that may be blowing. The balloons, as illustrated above, are fitted with a rigging and body harness similar to that used on a parachute. The jumper carries a certain amount of ballast with him, which can be used to control the lift of the balloon. For short jumps, a light yet strong rope attached to the balloonist may be held by those on the ground, or otherwise fastened, thus preventing the jumper from traveling far. When starting, the ballast and the gas in the balloon are so balanced that the gas-bag itself supports all of the jumper's weight with the exception of about four pounds. With this effective lightness, the aeronaut can jump many feet into the air, and by properly pushing himself at the take-off, can, to a great extent, govern the direction in which he will travel. To rise still higher, ballast can be released, while in the event of being carried off by a sudden wind, a valve is conveniently located so that gas can be released and buoyancy lost. There is a great possibility for competitive sport here, using these balloons for racing, high jumping, and similar contests.

EAST PORTAL AT BERNE

A short piece of track connects the east entrance with the main line. A one and one-half mile fill was made with debris from the tunnel



TUNNEL ENTRANCE AT WESTERN END

Here are shown the first forms that were laid for the concrete. Included in the photograph are the West Portal shield and tunnel entrance

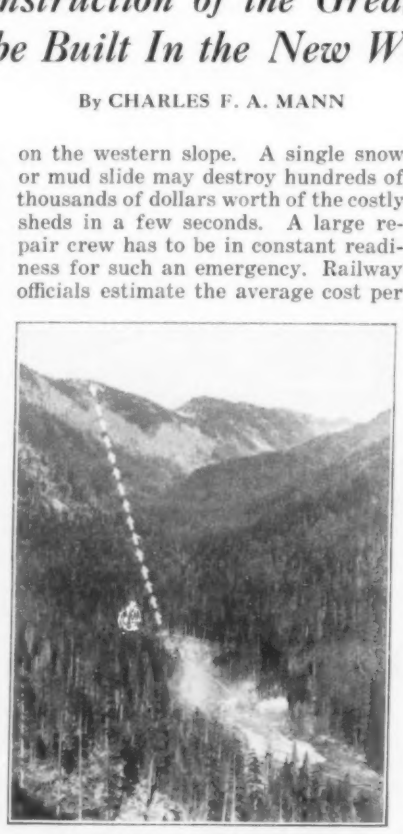
America's Longest Tunnel

Rapid Construction of the Greatest Tunnel to be Built In the New World

By CHARLES F. A. MANN

ONE of the most important pieces of engineering in progress at the present time in the United States, is the boring of the new eight-mile tunnel through the Cascade Mountains in Washington by the Great Northern Railway. The new tunnel when finished will be exactly 7.79 miles long and will be cut on a tangent across the Cascades from Scenic to Berne. When completed it will be the longest tunnel in the western hemisphere and the fourth longest in the entire world, exceeded only by the mighty cuts through the Alps between Switzerland, France and Italy.

The problem of crossing the Cascades has been an important one to engineers ever since the opening up of the Puget Sound country 70 years ago. The problems here are peculiar, inasmuch as the Great Northern, like other northwest roads, crosses the Columbia River in central Washington at an altitude of 608 feet above sea level and climbs to an altitude of 3,381 feet in 71 miles. At the summit of the Cascades the line descends sharply to an altitude of only ten feet at Everett, on Puget Sound, giving a rise and fall of well over 3,000 feet in 140 miles. In addition to the sharp grades and many curves, the lines are in constant danger in the winter months from the tremendous snowfall on the western slope. A single snow or mud slide may destroy hundreds of thousands of dollars worth of the costly sheds in a few seconds. A large repair crew has to be in constant readiness for such an emergency. Railway officials estimate the average cost per foot of these snow sheds at around 150 dollars.

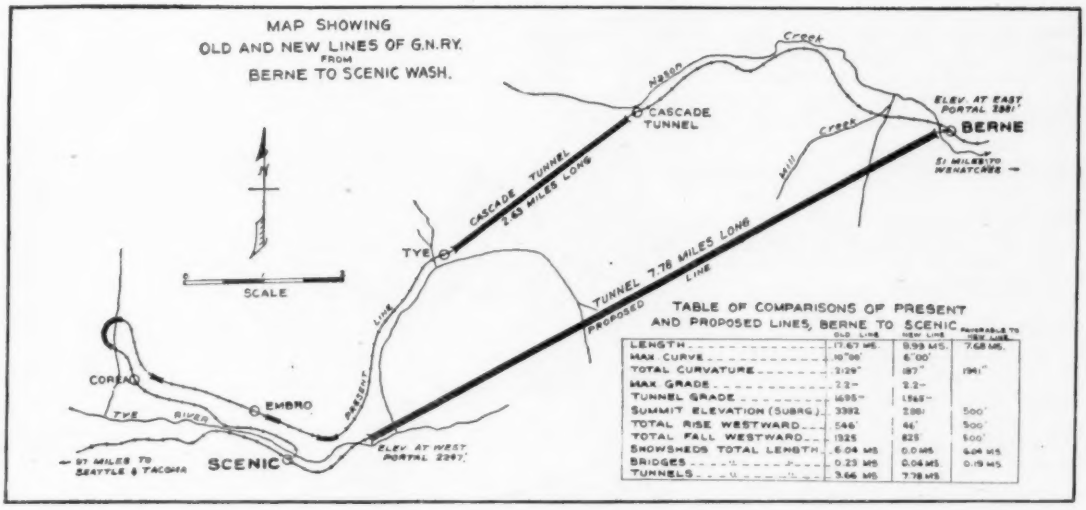


WEST PORTAL FROM THE AIR

The arrows show the route chosen for the bore through the mountain. The eight-mile tunnel will cut off eight miles of track and six miles of tunneling and snow sheds. This photograph was taken from a peak just northeast of Scenic

Summing up the problem as a whole, the engineering department of the Great Northern decided that in order to eliminate the heavy annual expense of hauling traffic over the mountains, and to speed up the service, a shorter route must be found. Accordingly, a surveying party was sent into the mountains early in 1925 and after a careful survey of hundreds of square miles of rocky country, selected suitable portal sites for a new tunnel at Berne on the east side and Scenic on the west. The comparatively small difference in elevation of Scenic and Berne made it possible to construct a tunnel with a 1.565 grade descending from east to west, with a total length of 41,136 feet and costing ten million dollars to build. The new tunnel will benefit the system in six ways:

1. It will eliminate the annual maintenance charges for renewal of snow sheds and the heavy expense of operating rotary snow plows through the snow belt.
2. It will afford permanent protection from snow slides and will eliminate the six miles of snow sheds.
3. It will reduce operating costs brought about by heavy grades requiring helper engines.
4. It will lessen the distance by several miles.



5. It will eliminate the excessive curvature in the Martin Creek loop.

6. It will lower the summit elevation by 500 feet and lessen the total rise and fall. It is estimated that when the new line is opened, four hours will be cut from the schedule of freight trains and that 17 train crews can be done away with.

After months of careful planning the Great Northern contracted with A. Guthrie and Company of St. Paul for actual construction of the tunnel. Immediately both organizations joined forces and built three camps, which are the finest ever built for caring for men working on a project of this kind. Model cities were built at Scenic and Berne, equipped with electric light and heat, sanitary sewage-removal systems, and running water.

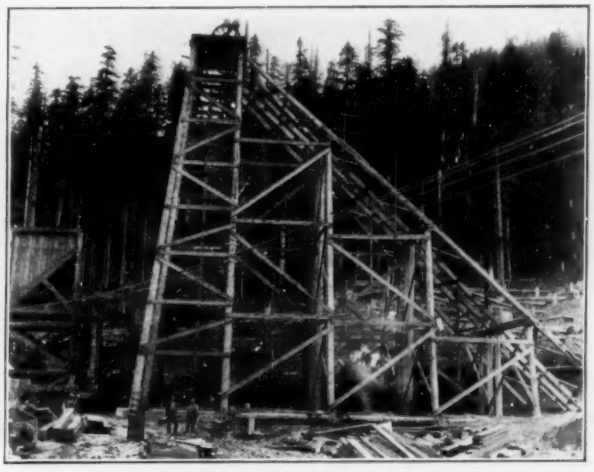
Everything is furnished all camps in order to make them as comfortable as possible, and special quarters are furnished married men with families. Indeed, a modern electrically lighted and heated school was built high up in the mountains for children of the workers. The bitter lesson of other large tunnel jobs pointed to the fact that every precaution must be taken in order to complete the bore by November, 1928, before the snows begin.

ACTUAL boring started early in 1926 and it was decided to use what is known as a pioneer tunnel paralleling the main bore. This runs from the west portal to the Mill Creek shaft, or for nearly six miles. The Mill Creek shaft was sunk about two and one-half miles west of the east portal, at what is known as Mill Creek valley. It is carried down 622 feet below the floor of the valley to subgrade of the main bore. Drilling and mucking operations are going ahead from both faces on the pioneer cut and the main tunnel. No pioneer tunnel has been run from Mill Creek to the east portal on account of the short distance and because all operations eastward are upgrade. Should excessive water inflow occur, all uphill operations could be stopped and there would be practically no necessity for extending the time. Using this system involves much extra expense; but where the work is done against time the saving will well repay the extra work. Cross cuts are made every 1,500 feet, and when finally all openings are being drilled there will be from 10 to 20 double-faced workings instead of two. Furthermore, this will give two outlets for air, water, light, ventilation and rail lines and will care for excessive inflow of water, one tunnel being plugged to handle water only.

The main center heading, which procedes the enlarged section, is 10 by 10 feet in size and is later enlarged by the top heading and bench methods to the full size of 18 by 25 feet. Separate crews timber the cut, and lastly the concrete lining is poured in at the rate of about 25 feet per day. The pioneer cut is 8 by 9 feet in size and is unlined. The method of cutting

A WORLD'S-RECORD CREW

These men bored through 1,157 feet of granite rock in 29½ days. The former record was a cut of 984 feet in 30 days, made in 1913



SHAFT-HEAD AT MILL CREEK

A shaft drilled to the grade of the main tunnel about two and one-half miles west of East Portal provided three exits instead of two

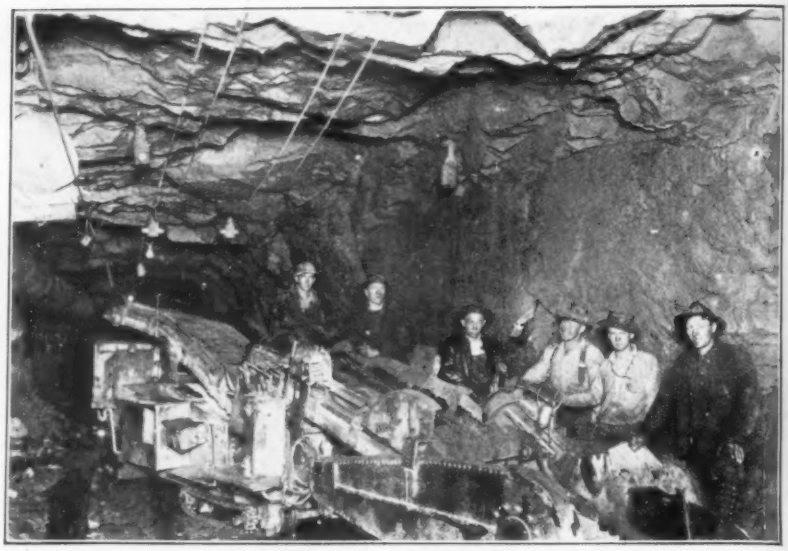
away the rock face, which is a varied mixture of fundamental gneiss and calcarious schist with occasional strata of hard fine granite, is interesting for its speed and accuracy. From 20 to 30 holes nine feet deep are drilled into the rock face by a set of drills mounted on a movable drill carriage braced against the rock. The holes are one and one half inches in diameter and are constantly kept free of dust by a stream of water flowing through the drill rods.

AFTER the holes are carefully tamped full of measured charges of blasting gelatin, the men and equipment are moved back about 2,000 feet and the charges are set off in five separate blasts. First the middle core is blasted. Another charge enlarges the loosened layer to a large cone; another loosens the outer edge; and one charge lifts the entire mass from the back face. Lastly a heavy charge blows the entire loosened section clear of the roof and floor. Automatic electric muckers scoop the debris into conveyors and drop it into mine cars. This cycle is repeated five or six times in 24 hours and it never stops from one month's end to another. The underground workers are supplied with hot food, and telephone communication is available clear to the face of the workings. Strong flood lights make the work a veritable movie studio, and there is less physical inconvenience than would be incurred in digging a large cellar where such details are overlooked.

From 40 to 50 feet per day is rated as excellent progress for the drill gangs and nearly two miles of pioneer tunnel have been driven. Concreting has been started at the west portal and is now in nearly 300 feet. Recently the world's record for drilling an 8 by 9-foot hole was established by a crew at the west portal. They drilled 1,157 feet in 29½ days through hard granite. The former record was held by a crew on the Rodgers Pass tunnel in British Columbia in 1913 when they cut a passageway through a distance of 954 feet in 30 days.

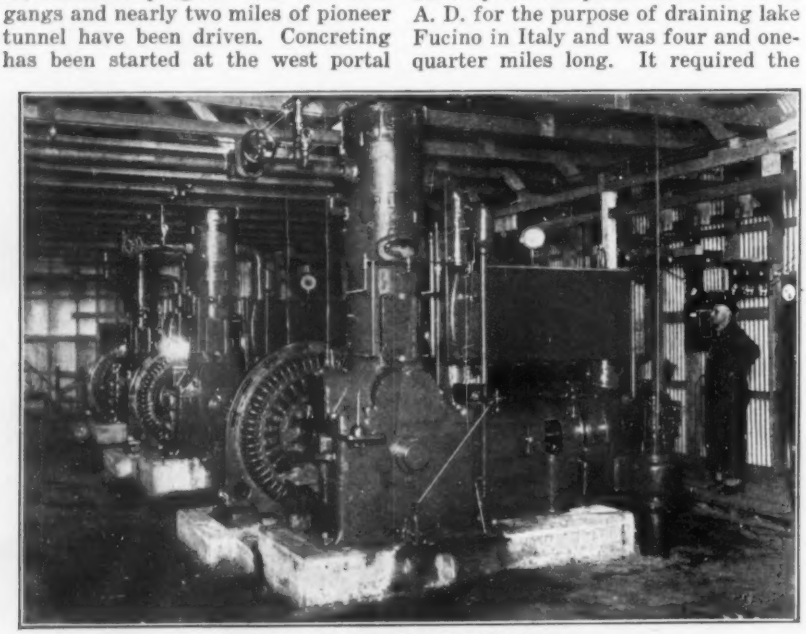
Contrast this marvel of engineering efficiency with the methods used in boring the world's first long tunnel nearly 2,000 years ago. It was built by the Emperor Claudius in 52 A. D. for the purpose of draining lake Fucino in Italy and was four and one-quarter miles long. It required the labor of 30,000 men for 11 years. Modern methods would have holed this tunnel in six months with 400 men and some compressed air and electricity.

When the two sections meet sometime early in 1928, the Great Northern will open a new era in transportation in the Pacific Northwest. Traffic to Puget Sound has increased by leaps and bounds. The heroic task of moving the heavy freight and passenger trains over one of the worst sections on the 2,000-mile journey westward from St. Paul will be much easier, and "on time schedule" will be easier to maintain than ever before in the history of the road.



A MYERS-WHALEY MUCKING MACHINE

Four men operating one of these machines can remove as much debris as could formerly a dozen men and a string of mules. The machines operate by electricity and can run in a five-foot tunnel



ELECTRIC AIR-COMPRESSORS

In order to keep the air-operated drills constantly at work, it was necessary to provide compressed air at a pressure of 120 pounds per square inch. The machines shown above handled all requirements

THE new tunnel marks the beginning of a long series of improvements which not only the Great Northern but other railroads are forced to make to maintain their standards under the pressure of modern traffic, and it is in keeping with the policies of other railroads of the country which, during the last 15 years, have spent hundreds of millions on eliminating curvature and grade. The new tunnel will eliminate over five complete circles of curvature or nearly 2,000 degrees.

Ever since the days of the famous switchbacks, which were first used in the Cascades to raise the trains over the mountains, the Great Northern has found snow to be its worst enemy. It now bids fair to ban the soft white monster forever.

This great work is being done under the personal direction of Colonel Frederick Mears, Seattle, with Mr. M. J. C. Andrews as Engineer in Charge on the work.

Stupendous Pressures

Pressures of Great Magnitude Profoundly Alter the Properties of Matter. How Extreme Pressures are Produced in the Laboratory

By P. W. BRIDGMAN, Ph. D.
Professor of Physics at Harvard University, Member of the National Academy of Sciences

The author, whose experiments with high pressures have opened an interesting field

THE pressures of ordinary experience may be arranged according to orders of magnitude in some such way as this. First, pressures of the order of tens of pounds per square inch, of which the pressure of the atmosphere is the most familiar. Next, pressures of hundreds of pounds per square inch, such as are met in steam engines or the explosions of gas engines. Next in order are pressures of thousands of pounds, such as we find in cylinders of compressed gas, which usually measure 2000 or 3000 pounds, or in hydraulic machinery, which sometimes operates to 5000 pounds. The next higher order is that of tens of thousands of pounds. Of this, the most familiar example is artillery, which operates usually at not more than 30,000 lb/in^2 (pounds per square inch). The pressure at the bottom of the ocean at its deepest part is in the neighborhood of 15,000 pounds.

The next higher order is that of hundreds of thousands of pounds per square inch. A number of years ago I devised methods for handling pressures of this order, and have been able to reach in the extreme case as much as 600,000 lb/in^2, although most of my work has been limited to more modest pressures of 200,000 lb/in^2. One may visualize a pressure of 200,000 lb/in^2 by imagining a 100-ton locomotive supported on a pin one square inch in cross section.

UNDER pressures of the order of hundreds of thousands of pounds, many of the properties of matter are profoundly altered, and there are many phenomena of great physical interest to be measured. But before entering on a systematic investigation of this field of high pressures it is evident that there were a great many new preliminary problems to be solved in the production, handling, and measurement of such pressures. I have thought that the readers of the SCIENTIFIC AMERICAN would be interested in hearing of some of the preliminary steps, since a great many interesting things were found in the preparatory work.

In the first place, this whole high-pressure field was opened somewhat by accident. I was engaged in an optical experiment under the quite modest pressure of 1000 lb/in^2, where one of the problems was the designing of a packing plug for a hole. On examining the plug after it was designed, I saw that incidentally it did very much more than was necessary, for it was such that it automatically became tighter as pressure increased, and thus could never leak, no matter how high the pressure, provided only that the walls of the containing vessel did not break. This packing at once opened an enormous field, for the highest pressure reached in previous research was about 45,000 lb/in^2, and the limit was set by leaks, and not at all by the strength of the containing vessels.

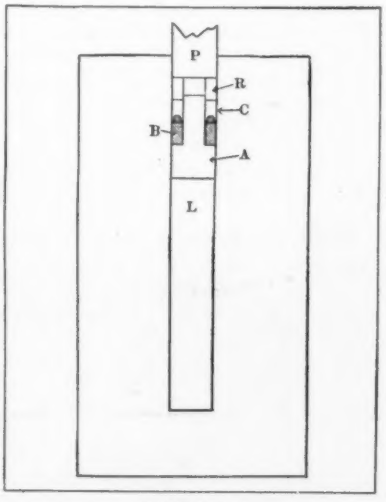


FIGURE 1

General principle of the packing by which the pressure in the packing B is always kept higher than that in the liquid at L

The magnitude of the field opened is shown by the fact that now after nearly 20 years' work I do not feel that I have much more than begun. The situation presented by the discovery of this new principle in packing was one of the few occasions where persistence in research is not a virtue. I immediately dropped the original problem to cultivate the new field, and have not yet had a chance to return to it.

The fundamental principle of the packing is shown in Figure 1, where is represented the method by which a piston is packed. The figure shows a piston (P) forced into a cylindrical hole in a steel block, compressing the liquid (L) with which the hole is filled. (R) is a ring of hardened steel, (C) is a cup-shaped soft-steel washer, (B) a packing of soft rubber, and (A) a mushroom-shaped piece of heat-treated steel. The essential feature is that the stem of the mushroom does not reach entirely through the ring (R), but its end is unsupported. This means that the entire push of the piston (P), which, of course, is equal to the pressure in the liquid except for friction, is transmitted to the mushroom through the packing (B). Now the area of this packing is less, by the area of the stem, than the total area of the piston, so that the pressure in pounds per square inch in the packing is greater by a fixed fraction than the pressure exerted by the piston and in the liquid. Hence the liquid can never leak *out* past the packing, but paradoxically, since the pressure in the packing is greater than that in the liquid, it is the packing that tends to leak *in* past the liquid. Any such inward leak of the packing can easily be prevented if the plug is a close fit for the cylinder.

IN practice, the stem of the mushroom is usually about one-half the diameter of the head, so that the area of the stem is one-quarter of the area of the head, and the area of the ring on which the packing pushes is three-quarters of the area on which the liquid pushes, and therefore the pressure in the packing is always 33 percent greater than that in the liquid. Thus if the pressure in the liquid is 30,000 lb/in^2, that in the packing is 40,000 pounds, and when the pressure in the liquid becomes 300,000 pounds, that in the packing rises to 400,000 pounds.

It is an interesting comment on the vagaries of patent law that a patent for this packing was refused because it had been previously used on the plunger of a sausage machine.

Having now this means of producing any pressure without leaks, the

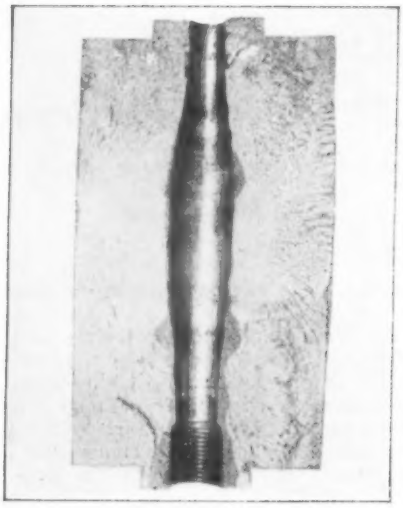


FIGURE 2

One of the halves of a cylinder of tool steel split by the application of internal pressure. The inner hole has stretched from one half to one and one fifth inches. The maximum pressure withstood by this cylinder was 600,000 pounds per square inch

first question was to find how high pressures could be reached without bursting the walls of the containing vessels. Of course, one does not double the strength of a cylinder by doubling the thickness of the walls, and engineers had long known that there is a practical limit beyond which it does no good to increase the thickness of the walls. The reason is that the inner fibers of the cylinder have to do by far the largest part of the work of supporting the internal pressure, since the more distant outer layers cannot help in supporting the pressure until the strain is propagated to them by the inner layers stretching far beyond their elastic limit.

ALTHOUGH no experiments had been made to find just how much pressure a very thick-walled cylinder would support, there were various theories, and these all agreed in saying that the maximum pressure possible was about equal to the ordinary breaking strength of the metal. Thus a cylinder made of ordinary mild steel of a tensile strength of 60,000 lb/in^2 would not be expected to support more than 60,000 pounds internal pressure, even if the walls of the cylinder were infinitely thick. Very fortunately, this estimate of theory turned out to be much too low. The fact is that in a thick-walled cylinder the inner fibers are so supported by the outer fibers that they can stretch very much more without breaking than they can under the conditions of the ordinary tensile tests, and so allow the outer fibers to assume a greater share of the load than was thought possible.

This possibility is shown in Figure 2, which is a photograph of one of the halves of a cylinder of ordinary tool steel broken by an internal pressure of 600,000 lb/in^2. The tensile strength of such a steel is not more than 150,000 pounds, so that this cylinder actually supported four times as much pressure as the simple theory indicated. The photograph also shows the great stretch of the inner fibers; their elongation was 140 percent, whereas not more than 25 percent is possible under ordinary conditions. Most paradoxical of all, the cylinder broke at the outside surface, where stress and strain are both least, instead of at the inner surface, where both stress and strain are a maximum. Such phenomena evidently give very important light on the theories of rupture of metals, into which, however, there is not space to enter here.

In Figure 3 and 4 are shown two other examples of cylinders broken by internal pressure. Figure 3 is a cylinder of mild steel, the maximum strength of which under ordinary tensile tests is 60,000 lb/in^2, which required over 200,000 lb/in^2 to break it as shown. The inner hole was stretched from ½ to 1⅜ inches, or 175 percent. Figure 4 is the cross section of a cylinder of copper; this required 150,000 lb/in^2 to break it, against a breaking strength in ordinary tension of 30,000 lb/in^2. The inner hole stretched 200 percent, from ⅛ to ⅜ inch, before rupture took place. Notice that in copper the rupture traveled in from the outside along a sort of spiral; this is quite characteristic.

IF a heavy cylinder is stretched beyond the elastic limit, so that the internal layers receive a permanent stretch, and pressure is then released, the cylinder is put into a condition of internal stress very much like that in a built-up gun, in which there is compression at the inner layers and tension at the outside, except that the distribution of stress is very much more uniform than that possible to reach in a gun by shrinking on hoops. This principle offers a very much better and cheaper way of constructing large artillery; experimental guns were made by this method during the war, and now such guns are in regular construction.

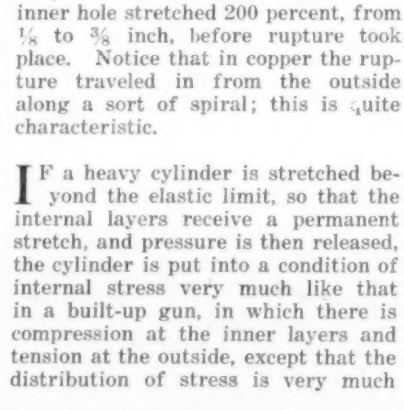


FIGURE 4

Cross section of a copper cylinder burst by the application of internal pressure. The inner hole was stretched from ⅛ to ⅜ of an inch

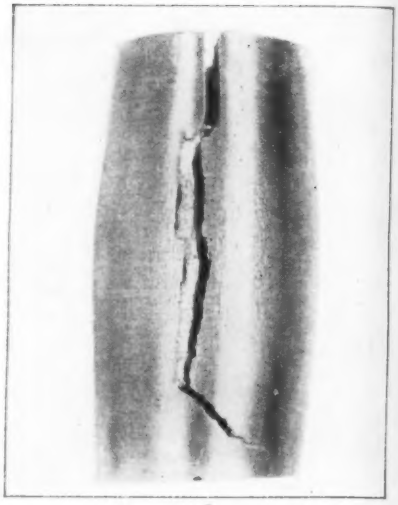


FIGURE 3

A cylinder of mild steel ruptured by excessive internal pressure. This cylinder was originally two inches in outside diameter and one half inch in inside diameter. The inner hole was stretched until it measured one and three eighths inches in diameter

Another problem on which much thought was expended was that of the piston by which these high pressures were to be produced. Many designs of elaborate apparatus were made, in which I attempted by various features of design to make the average compressive stress in the piston less than the pressure which it produces in the liquid. Fortunately all such elaborate schemes proved unnecessary because the strength of steel for the simple compressive stress which the piston must support turned out to be much higher than expected. Steel, when glass hard, can support an astonishingly high compression, although for most purposes glass-hard steel is much too brittle.

MANY different grades of steel were tried; any high-carbon steel that can be made glass hard will support 450,000 lb/in^2 or more, and I found one steel that required 750,000 lb/in^2 to break it in pure compression. My experience with the piston emphasizes the enormous value of simplicity in design. The results of my experience can now after many years be reduced to an extremely simple receipt for producing the highest possible pressures: Take a strong piece of steel, bore a hole in it, fill the hole with a liquid and close the hole with a plug that will not leak, and push as hard as you can on the plug.

Another problem was to devise a method for piping a liquid under high pressure from one vessel to another, for obviously the experimental methods can be much simplified if the apparatus can be made in several parts connected by pipe. This was brought forcibly home after spending a month constructing a complicated apparatus of one piece of steel to avoid connecting pipe, and then having it break on the first application of pressure because of a flaw in the center of the ingot. The difficulty of flaws in the metal proved very serious, for, as may be imagined, pressures

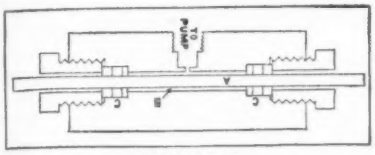


FIGURE 5

Apparatus for producing the "pinching-off" effect, that is, separation of the longitudinal fibers by the application of pressure to the curved surface of a cylinder. The specimen is shown at A. The fluid exerting the pressure by which rupture is produced is contained in the annular space at B

as high as these will find out the minutest flaws. This particular difficulty has become much less serious in the last few years with the introduction of sound steel made in the electric furnace.

To return to the pipe, it is possible to obtain commercial steel capillary tubes with an external diameter five times the internal diameter, but such tubes will not stand permanently more than 60,000 lb/in^2. The difficulty was finally met by working out a method for drilling the connecting tubes from the solid rod; I have made such tubes with an internal diameter of 1/16 of an inch and 18 inches long.

THE early work was not without a certain amount of danger, explosions continually occurring, and pieces of steel flying about with velocities sometimes high enough to penetrate six inches of hard pine planking. These dangerous ruptures were finally found to be all of the same type, and to involve a possibility not previously recognized. This type of rupture was afterward studied for its own sake; in Figure 5 this sort of rupture is illustrated. The rod (A) passes completely through a high-pressure cylinder, coming out through stuffing boxes (C), and within the cylinder its external curved surface is exposed to hydrostatic pressure exerted by a liquid in the annular space (B). When the pressure in the liquid rises high enough, the rod parts in the center just as if it had been pulled apart by a tensile load, and the two parts of the rod are expelled through the stuffing boxes with much violence.

In Figure 6 is shown one of these pinched-off rods; the pinching took place at the pointed end. For safety, the rod was expelled into a hole in a massive block of steel. The violence of the expulsion is suggested by the fact, which can be easily detected in the photograph, that the diameter of the rod was appreciably enlarged for at least one third of its length.

The paradoxical feature of this sort of rupture is that there is no *force* lengthwise of the rod tending to make it break, but nevertheless the fibers are lengthened in this direction and eventually break. The effect in principle is much like pinching off a roll of putty between the fingers, only here the putty is solid steel, and the fingers which pinch it are a mobile liquid. The importance of such a type of rupture for the theories of the engineer is evident.

A VIEW of one of the finally evolved pieces of apparatus which has been in constant use for many years is shown in Figure 7. Pressure is produced in the upper cylinder (A) by a small piston (B) (½ inch diameter) driven by the larger piston (C) (2.5 inches in diameter) of a hydraulic press, which in turn is operated by the hand pump (D). By means of the valves at (E), the pump (D) may be connected at will to the piston (C), or to the small hydraulic intensifier (H). The intensifier is used to produce in the high pressure parts of the apparatus an initial pressure of 30,000 lb/in^2. This initial pressure compresses to negligible volume any air accidentally present in the apparatus, and also takes up a large part of the compressibility of the liquid, thus making it possible to reach 200,000 lb/in^2 with a single stroke of the high pressure piston,

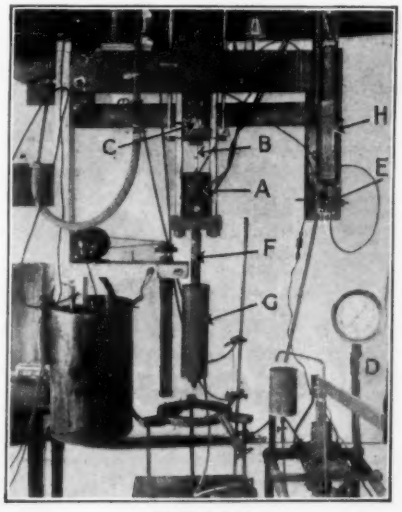


FIGURE 7

A photograph of a standard high-pressure assembly. The letters are explained in the text directly above

which could not otherwise be accomplished because of the necessary absence of all valves in the high pressure part of the apparatus. The upper cylinder (A) is connected through the pipe (F) with the lower cylinder (G), which may be removed and altered to suit the experiment.

PERHAPS an unexpected feature of the apparatus is its small size, the cylinders being not over five inches in diameter. There is a real reason for this, because only the strongest steel will stand these pressures, and steel must be heat treated to bring out its greatest strength, and only small pieces of steel can be heat treated throughout their entire mass.

With this apparatus a great many new phenomena have been investigated which there is no space to describe here. Most of these phenomena have been accurately measured.

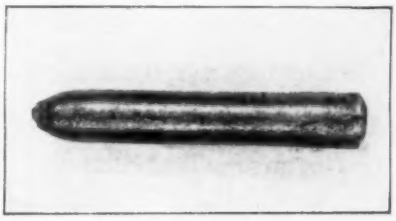


FIGURE 6

A "pinched-off" rod. Notice the upsetting of the diameter for a third of the length of the rod, suggesting the extreme violence of the effect

Some of them, however, were of interest primarily because of their bearing on the design of the apparatus, and these were investigated only qualitatively. Thus it was found that no steel cylinder will support more than about 90,000 lb/in^2 without rupture, when the pressure is transmitted to it by mercury. The reason is that the atoms of the mercury, which are very small, are driven by the pressure between the atoms of the steel, where they amalgamate it. Another surprising effect is that many substances normally soft and pliable become enormously hard and stiff under pressure. Thus it is not possible to transmit a pressure of more than 60,000 lb/in^2 with ordinary oil, because the oil becomes so stiff that it no longer flows under pressure. Paraffine wax is made by pressure harder than ordinary machine steel; it is quite easy under high pressure to make a piece of steel flow by pushing it with a piece of paraffine. Soft rubber acts in the same way and becomes very hard. Sometimes a soft rubber washer becomes so brittle that it cracks under pressure, and then the soft steel in contact with it is forced in ridges into the cracks in the rubber. That is, under high pressure soft rubber becomes so hard that it may be used as a die to form steel.

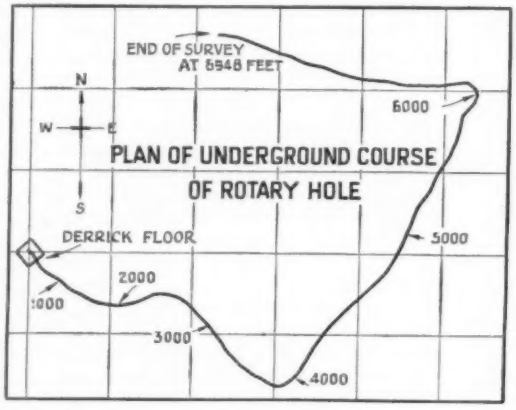
The Wanderings of An Oil Well

Automatic Surveying Machine Shows World's Deepest Well to be 517 Feet Out of Plumb at 6,000 Feet Depth

IT is probable that the men who rush off to a newly discovered oil district, put up a derrick, and begin to bore for oil, believe that they are driving their drills vertically into the ground beneath them. If the drill should not go where it is pointed, it would be a serious matter for these adventurers, for the derrick is erected and the drilling is started upon a plot of ground which is selected under the belief that the quickest way to get at the oil is by a vertical well running straight to the supposed oil reservoir below.

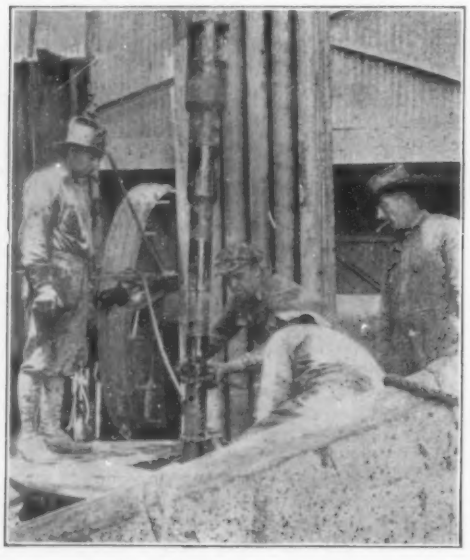
Not all of the experienced well drillers, and certainly not the trained mining and petroleum engineers and the geologists, have such a simple faith in the good behavior of the oil drill. These expert men are well aware that the progress of the drill on its way down to the oil-bearing sands is apt to be somewhat erratic; but none of them was able to determine the extent or the direction of these deviations from the vertical. If the well hole had only been big enough to allow one to descend, carrying with him a level, inclinometer and compass, it would have been a very simple matter to plot the deviations, both in the vertical and the horizontal plane, but this, of course, was impossible; the diameter of the well was altogether too small for that.

It was reserved for a well-known mining and petroleum engineer, Mr. Alexander Anderson of Fullerton, California, to design a small and very ingenious instrument that is capable of making such a survey. It is so small that it can be lowered bodily into the drill hole, and so accurate that, in its course down to the bottom of the well, it automatically records and photographs on a reel of film its exact position at any desired depth.



The survey machine proper consists of a tube, 3½ inches in diameter and 7 feet long, as shown in the accompanying photograph. At its lower end is a conical plug welded into the tube. At its upper end, a top plug is welded into the tube, and this connects by a coupling to the tool joint pin at the bottom of the drill pipe. Attention is directed to the photograph showing the head of the well. At the back of the picture are seen several lengths of drill pipe, each section being 85 feet long. In the center at the top of the picture is the end of the main drill pipe, (the drilling machine, by the way, being of the rotary type,) and below this the pipe reduces in diameter until it is screwed into the top of the survey machine, which will be noticed projecting somewhat above the mouth of the drill hole. The man to the left is standing upon the circular drill table, gear-driven, by which the boring bit is operated. The man in the center is screwing the survey machine into the tool joint pin by means of a sprocket wrench. When the coupling up of the survey machine has been completed, successive lengths of the 85-foot pipe will be screwed on as the machine is lowered into the well. At stated intervals the recording apparatus within the little tube will make a photographic record of the inclination and of the variation in azimuth of the survey machine at successive levels.

Now, consider the photograph shown in the bottom right-hand corner of the page. This is a demonstration frame which serves to show the method of operation of the survey machine. The 7-foot 3½-inch tube is supported by three rods upon a circular ring baseplate. Note the screws passing through the lower flange of

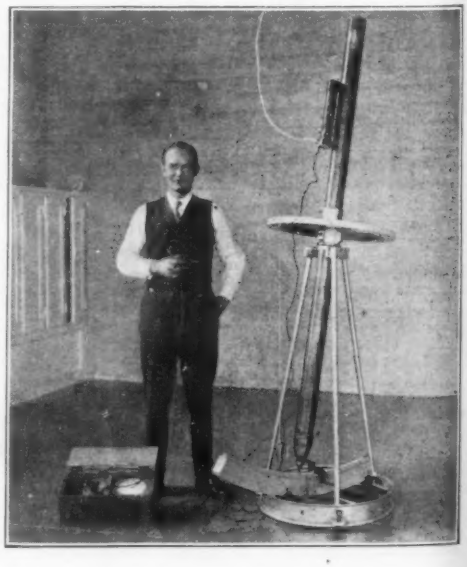


TOP OF WELL

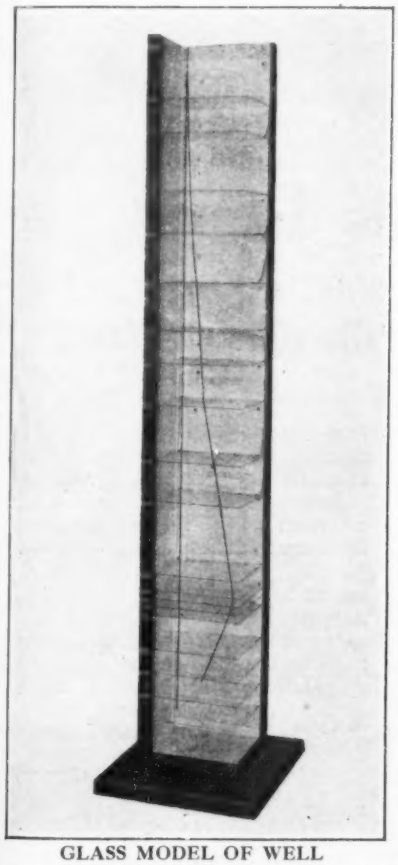
LEFT: *This shows top of well. Drillers are attaching the tubular surveying machine to bottom of drill pipe. Note group of "stands" ready to be coupled on as the pipe is lowered into the well*

THE OUTFIT

RIGHT: *The inventor demonstrating the operation of the surveying machine. It is so mounted on a tripod that it can be given movements similar to those which occur when it is lowered into a well*



the ring by means of which the tripod can be leveled up. The tube is so supported at its mid-length that it can be swung freely in a vertical plane. Above its point of support, there is clamped to the tube a metal compass-card, or graduated horizontal circle. The amplifier attachment, and the telephone receivers, which will be noted in the hands of Mr. Anderson, are for listening in on the mechanism, and coordinating by stop watch with a time schedule on which "shots" are taken during the lowering of the survey machine into the well. Carried on the base ring of the tripod and provided with set screws for its adjustment, is a graduated vertical arc



GLASS MODEL OF WELL

The horizontal plates represent planes at various depths. The dark line to the left represents a plumb line from the derrick floor. The other line traces the exact path of the well hole through the various geological formations encountered

which is provided with a clamp attachment by which the survey tube can be held in any determined position.

The illustrations show some of the surprising facts which were brought to light by a survey with this machine of the famous Olinda Well Number 96 in Orange County, California. This is the deepest well in the world. At the time that this survey was made, May, 1926, it had reached a total depth of 6,948 feet. At the present writing, it is down to over 8,000 feet.

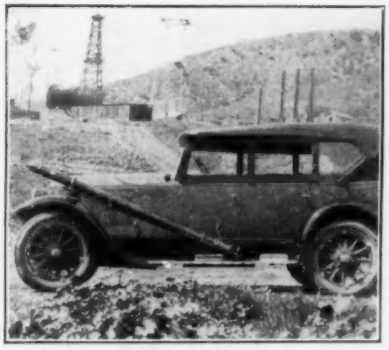
We present a photograph of a glass model which was built to show the amount of deviation from the vertical at the different levels. The plan of the underground course of the hole proves that, in addition to traveling very much out of plumb, the drill also moved in a general circular or rather rectangular direction. It shows how the course of the well would appear if it were projected onto the surface of the ground above. The survey machine was lowered into the well to a measured depth of 6,522 feet. After each stand of pipe was attached and lowered, the machine automatically made a photographic record; an additional reading was taken at the bottom of the hole, making a total of 75 photographic readings. The survey started at 8:45 A.M. and reached bottom at 3:50 P.M. The following July, when the hole was 1,000 feet deeper, the machine was again lowered to the bottom of the well.

MR. ANDERSON tells us that unexpectedly high temperatures were encountered and that they incapacitated the batteries inside the machine, so that the photographic record ceased at a depth of 6,948 feet. The temperature was determined by laboratory tests made on similar batteries, and it was found to have been about 212 degrees, Fahrenheit. It is believed that with the use of improved insulation inside the machine, the survey can be carried down to 8,000 feet. The first part of the hole, to a depth of 3,751 feet, runs in a general southeasterly direction; then the slope of the hole changes to a northeasterly direction and follows this course down to a measured depth of 5,962 feet. Here, the hole swings sharply around to a direction north 75 degrees west and maintains this course with the last reading at 6,948 feet.

The glass model shows that there is a rather even rate of departure from the vertical from near the top of the well to the 6,000-foot level where the hole is not less than 517 feet off vertical. From that level, it swings back towards the plumb line and is 348 feet off vertical at 6,948 feet depth.

Now, let us see what is the significance of these erratic wanderings of the well hole as revealed by survey. Let us suppose that oil had been struck at the depth of 6,000 feet, where the lateral drift has carried the well to its extreme distance of 517 feet, measured horizontally from the derrick floor. This would mean that under the derrick there would be exactly 30 acres of untapped area.

Mr. Anderson, writing in *Petroleum World*, tells us that there is a good deal of literature dealing with the



TRANSPORTING THE MACHINE

The device is carried long distances from well to well. It rides on a steel frame, designed to protect it from shock

spacing of derricks according to theoretical considerations. Such suggestions show that the great underground drift of wells was not formerly appreciated. Underground surveying of California rotary wells has demonstrated that wells in the same field do not follow parallel lines underground; the amount of drift of two adjoining wells might also vary within wide limits. It is surprising to learn from this authority that Olinda Number 96 is by no means an exceptional case of large drift, since the drift of some shallow wells has been found to exceed that amount. Furthermore, the fact that wells drift in different directions and by different amounts suggests that areas of untapped oil sand may exist under leases that are seemingly fully drilled.

THE SURVEYING MACHINE

This consists of a steel shell 3/16 of an inch thick, three and one half inches in diameter and seven feet long, within which are batteries and an ingenious mechanism for recording photographically the inclinations and positions of the well at various points in its wanderings from the perpendicular. The results obtained are fully described in the text

DETERMINING THE EFFECT OF SUNLIGHT ON PLANT GROWTH

The plants to be tested are placed on small cars and exposed to sunlight for definite periods

Our Agricultural Ellis Island

How the Department of Agriculture is Using a Famous Old Virginia Estate as a Testing Ground for Immigrant Plants

By GEORGE H. DACY

ALMOST under the shadow of the huge radio towers at Arlington, Virginia, and contiguous to the borders of our greatest national cemetery, is located the finest plant proving-ground under the sun — an outdoor laboratory for grain, grass, fruit, flower, crop, bulb and soil research whose fame has reverberated around the world.

Spacious and palatial Arlington Farm, a cradle of American history and a clearing house through which thousands of foreign crops, fruits, nuts, berries and vegetables have gained citizenship in these United States, annually attracts agricultural scientists and visitors from the four quarters of the earth. It is unique and unrivaled in its distinctiveness. There is not another experimental enterprise in all creation that is the equal of this farming estate which nestles close to the banks of the meandering Potomac.

FATE'S shuffle has written a most curious history at Arlington Farm. Once it was the beloved home of the notable Custis family of Virginia, and was widely heralded as a center of lavish hospitality. Later, it was the scene of some of George Washington's surveying exploits. Our first President surveyed and constructed a viaduct under the historical Chesapeake and Ohio Canal which penetrated a part of Arlington Farm and is still in use. Subsequently, General Lafayette and his son visited at the manor house which once stood where the superintendent's home at Arlington is now situated. After the tumultuous times of the Civil War, Arlington—once the scene of brilliant fetes and parties—slumped into discard and was used by the War Department as a mammoth pasturage for army mules. Negro squatters took possession of some of the outlying land, where they built crude cabins.

It was exactly 26 years ago when the War Department transferred the tract of 400 acres to the United States Department of Agriculture to be used as a plant, fruit and crop experimental station. From then to the present day, government experts have been busily engaged in reclaiming the impoverished fields, and in providing essential buildings, laboratories, greenhouses, fertilizer factories, cold storage facilities and other research appliances. Today, Arlington Farm is the official testing ground for the most extensive experimentation in soil tillage, crop production and plant life ever attempted. Uncle Sam spends from 350,000 to 400,000 dollars a year in scientific research at this great establishment. Epochal results have been secured since the inception of the test farm, and these justify its existence forever. The investigations have saved untold millions of dollars annually for American agriculture.

Fully to appreciate Arlington Farm, one must browse through the pages of dog-eared histories and time-stained records. They add the sparkle of romance and the tinge of adventure to a national estate which now is used as a try-out center where old theories, new-fangled ideas and agricultural speculations and surmises are subjected to thorough tests.

Where John Parke Custis once produced corn, cotton and tobacco and where his son, George Washington Parke Custis, later lived and gained fame as a prince of hosts, Uncle Sam, master-farmer, now cultivates rolling fields and level bottomlands.

THE King of England granted a patent to the colony of Virginia to Lord Culpeper and the Earl of Arlington, during the days when knee breeches and silken ruffs were in style. Arlington Estate was christened in honor of the latter celebrity, by a certain Robert Howson who secured a grant to 6000 acres of Northern Virginia land from Sir William Berkeley. Eventually, Howson traded Arlington to General John Alexander for 64 hogsheads of tobacco.

During the latter months of the Revolutionary War, John Parke Custis purchased 1100 acres of Arlington

Estate from General Alexander, paying 1100 pounds in Virginia currency for the property. Mr. Custis was the son of Martha Washington, America's "first lady of the White House." George Washington Parke Custis, the adopted son of General George Washington, in the course of time, became the sole owner of Arlington through inheritance.

The first agricultural fairs and live-stock exhibitions in the United States were celebrated at Arlington Estate during the occupancy of George Washington Parke Custis. He was a pioneer patron of pure-bred stock. He offered prizes and the use of his estate to rival stockmen and farmers who assembled their fat, sleek-conditioned horses, cattle, sheep and swine in order that experienced judges might select the annual champions.

Upon the demise of George Washington Parke Custis, Arlington became the property of his daughter, Mary Ann Randolph Custis, who, in 1831, was married to Cadet Robert E. Lee of the West Point Military Academy.

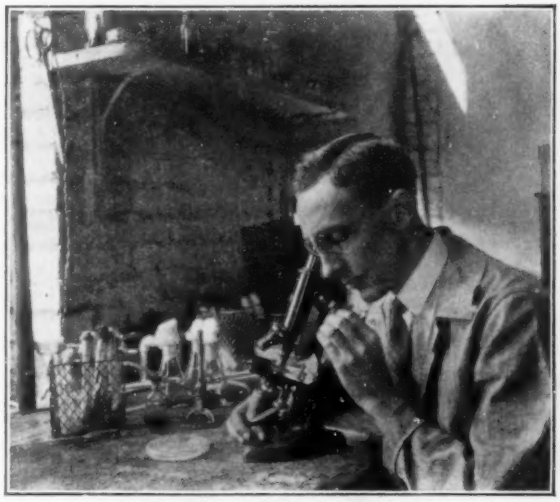
THE next remarkable events chronicled at Arlington, occurred after the abandonment of the estate by the Lee family, Robert E. Lee moving to Richmond where he became military leader of the Confederacy. Shortly thereafter, Arlington was confiscated by the Federal Government and was used for some time as one of the Union Army headquarters. Three years later, it was sold for tax arrears and was purchased by Uncle Sam for 26,000 dollars. It was not until 1877 that the Lee family finally won a settlement from the Government for its treasured and cherished estate. At that time, the courts awarded 150,000 dollars to George Washington Lee, the chief surviving heir.

The original Arlington Estate is now subdivided into three units, each of outstanding national and historical importance. One tract composes Arlington Cemetery, designated as such by Abraham Lincoln. Another portion now consists of the Fort Meyer (Virginia) Military Reservation where leading detachments of the United States Cavalry are stationed. The third body of land has been improved and perfected as Arlington Farm, where America's most intricate crop-production riddles are solved.

You can appreciate that the plant research at Arlington Farm can be continued to the millenium when you understand that civilized man now uses only about 200 of the more than 500,000 distinct species of plants which have been identified. One of the great works of the Department of Agriculture is to introduce and test out at Arlington Farm as many of the unused plant varieties as are adaptable to American soils and climate. This is a prodigious assignment.

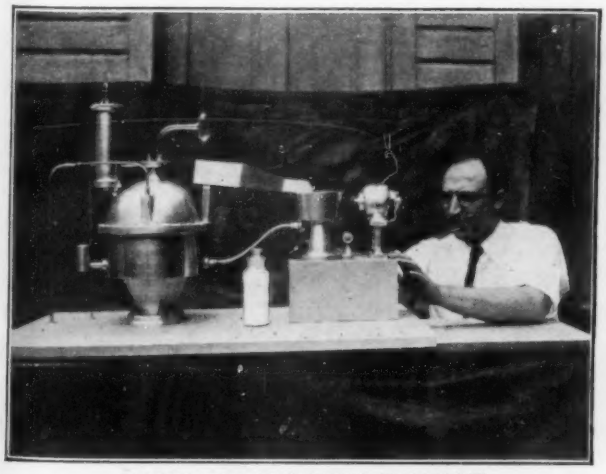
Take the case of soy beans, for example. All the leading species of this billionaire crop now in use in the United States were first tested as plant immigrants at Arlington Farm. Selections were made which have proved to be valuable mortgage-lifters in the different sections of our continent. Today, more than 1,500 additional varieties of soy beans are being studied by science as they grow in Arlington's fertile fields. Translate these figures pertaining to one specialized crop into terms of the several hundred crops which are experimented with, and you can visualize the magnitude of this matchless agricultural project.

EVEN in this day of our 48 state experimental farms, agricultural colleges and thousands of sub-stations with scientific experts working constantly, the food-producing power of the world is still practically unknown. This is because science has only just begun to study, in a modern way, the relative performance of different plants. Arlington Farm is the leader in this campaign to unlock the secrets of plant production which, since the dawn of human existence, have been barred from man's knowledge. To help find the plant which will produce



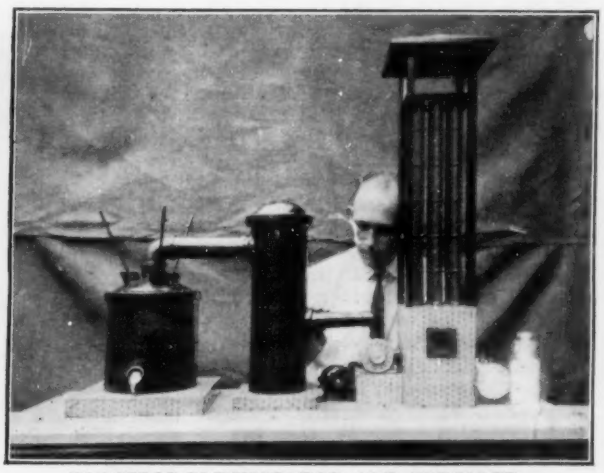
STUDYING SOIL BACTERIA

Tiny bacteria annually manufacture 1,000,000 tons of nitrogen which is stored as plant food on the roots of clover, alfalfa, beans and peas



MODEL OF FERTILIZER FACTORY

This plant, designed by government experts, when built in full size, will be used for making concentrated fertilizer



ELECTRIC PRECIPITATOR AND FURNACE

This is another model of an efficient apparatus of government design that is a result of work at the Arlington Farm

A COMPLETE FERTILIZER FACTORY

One of the full-size manufacturing-plant installations at Arlington Farm

the best food results of any that can be grown on every acre of land in this country, is, in general, the broad policy of the United States Department of Agriculture. A veritable flood of plant life annually flows from all parts of the globe to Washington and eventually is tested under practical field conditions at Arlington.

The finest arterial highways and cross-country boulevards in America trace back to research of one kind or another which has been consummated at Arlington. The Bureau of Public Roads, since its rise to international prominence as a highway investigator, has conducted the majority of its experiments at this research factory. The purpose of many of these tests has been the ultimate development of standardized systems of highway construction—the building of roads which will not only withstand current vehicular traffic but which will resist the wear and tear of the ever-increasing potential burdens and loads.

The influences of freezes and thaws, drainage and drought on permanent roads have been surveyed; viralithic and strength tests of concrete have been made. Subgrade research, the effects of six-wheeled trucks on highways, the impact influences of heavy loads, the use of original machines to simulate heavy traffic on test roads —these and hundreds of other experiments have been performed.

MUCH that we know about soils and fertilizers results from Arlington's practical research. During the last 14 years, experiments in the production of high quality, concentrated fertilizers from low-grade materials have yielded revolutionizing results. In this campaign, the government specialists had to invent new fertilizer factory appliances, including electric blast-furnaces. They perfected miniature fertilizer factories and made the experimental products under commercial conditions. Now they are testing these concentrated fertilizers—the "T. N. T." of the plant food world—in all parts of the country. The potential results will be the annual saving of millions of dollars in fertilizer freight and storage bills. The concentrated fertilizers, which are four to five times as rich in plant food as ordinary commercial fertilizers, can be shipped long distances at comparatively low costs and used to grow three stalks of grain where one half-starved specimen previously was produced.

The fine turf gardens at Arlington are the best which greensward technique ever grew. The United States Golf Association co-operates with the Department of Agriculture in testing out hundreds of different kinds of grasses, fertilizers, greens-keeping methods and insect and disease eradication systems at this northern Virginia station. The creeping and velvet bents—the premier golf-greens grasses of the central, northern and northwestern United States—have been selected and improved. The Government's tests of grass growing annually save millions of dollars to the 2,000 or more golf club courses and public links now in use in this country.

TWO hundred acres of cultivated crops were grown, mostly in diminutive experimental tracts, at Arlington last year. Breeding, disease resistance, fertilizer, soil-inoculation, self-sterility, germination and seed treatment tests of various kinds have been made. Such important commercial bulbs as Easter lilies, narcissus, hyacinths and tulips are being raised under practical field conditions to solve all the commercial problems associated with that economic industry. Several acres of drug and poisonous plants are also produced for scientific purposes. Field and greenhouse studies of root-nodular bacteria which occur on all leguminous plants are in progress. Crop rotation as it influences the development of beneficial and harmful bacteria is also under the microscope of scientific test. The riddles of sugar beets, tobacco, cotton, sugar cane, vegetables, truck crops, grains and hays are being explored and answered accurately from practical investigations under "dirt-farm" conditions.

More than 50,000 introductions of

BLAST FURNACE FOR FERTILIZER EXPERIMENTS

Here is only one of the many large installations made by government experts

foreign plants have been raised under the observant eyes of farming experts. Durum wheat brought in from Russia 18 years ago, tested and popularized by Uncle Sam, now yields 40,000,000 bushels, annually worth 60,000,000 dollars to American farmers. Hairy Peruvian alfalfa imported in similar manner and acclimatized in California, now adds an extra 5,000,000 dollars a year to the farming income of the Golden State. The notable Pima cotton of Arizona, which produces a 20,000,000 dollar annual crop, was introduced from the Nile-fed fields of Egypt via the United States Department of Agriculture.

AMERICA'S date and fig growing industries came into being through Arlington Farm's assistance. Sudan grass from Africa which made good in Virginia trials, now is an established economic crop in this country. It produces hay and forage worth 15,000,000 dollars every 12 months. Japanese sugar cane, a 4,000,000 dollar crop, Rhodes grass, a million dollar forage, Siberian millet, another millionaire, and *feterita* from the Sudan, which produces 12,000,000 dollars' worth of feed a year, are other plant immigrants which have been naturalized in the United States as a consequence of Arlington's scientific aid.

A rare tree from Molokai, now under test, produces a crop like cotton; a tropical tree from Nigeria yields berries which will even sweeten vinegar; a palm tree from Para which bears a food like a potato; a new fruit tree from West Africa with bunches of edible peach-like fruits; a variety of Job's-tears from Brazil; *spekboom* from South Africa; *huauhtli* from Mexico, a grain raised extensively by the Aztecs which prospers in arid regions too dry for corn; *chayotes* from Central America; the *inga*, a tropical walnut from Guatemala, and the *m'tsama* melon, the chief water supply of travelers in the Kalahari Desert, are other extraordinary plant immigrants now being grown under national observation.

The wonderful discovery that daylight exposure is the most important factor which influences plant growth was made at Arlington, where a multiplicity of plant specimens were maintained in cells as dark as the corridors of Stygia. These plants, in tubs and boxes placed on small cars, were hauled outdoors daily on steel tracks and exposed to sunlight on definite schedules. These experiments revised the world's oldest theories about plant growth, for they proved that daylight was more important than either temperature fluctuations or seasonal cycle in the development of plant life.

THE EXPERIMENTAL ROSE GARDEN

This garden at Arlington Farm is run in cooperation with the American Rose Society

PROBABLY the finest collections of roses and peonies ever grown are raised annually at Arlington in cooperation with the American Rose Society and the American Peony Association. Excellent collections of iris, hardy chrysanthemums and other ornamentals are also produced.

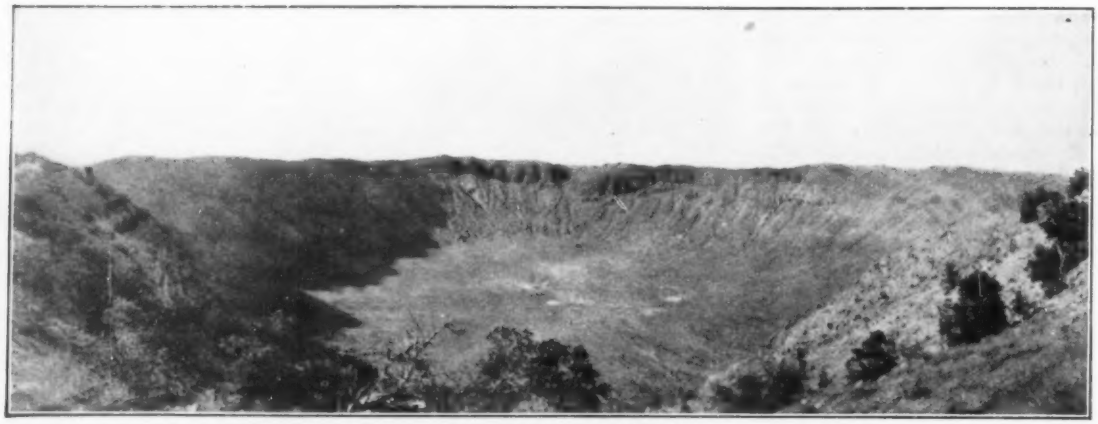
The Government operates a large experimental cold-storage laboratory at Arlington, where the responses of fruits and vegetables to simulated marketing journeys and processes are studied. A circulatory refrigerated brine system penetrates the 16 cold-storage rooms whose combined capacity is eight carloads of foodstuffs. Potatoes, citrus fruits, nuts, perishable vegetables and similar products are stored and studied under a vast variety of conditions.

The national Bureau of Chemistry also maintains an important color laboratory at Arlington where research in the certification of food colors is conducted. Investigations of biological stains and dyestuffs have also been made. The outstanding grain-dust explosion research, which has saved hundreds of lives and many million dollars' worth of property for American industry during recent years, has been carried on at the estate where the Custis family formerly resided. Small models of grain elevators, factories and food-supply plants have been made and blasted to smithereens in the process of these trials.

All in all, Uncle Sam's 26,000 dollar land purchase has proved of inestimable worth to the nation.

TESTING GRASS FOR GOLF GREENS

Determining the suitability of grass for greens is an important part of the work



INTERIOR OF METEOR CRATER, NEARLY A MILE ACROSS

Here the photographer stood on the south rim, roughly above the position of the supposed meteoric body, looking in a general northerly direction. See drawing at top of opposite page

The Most Fascinating Spot on Earth

A Comet, Weighing Millions of Tons, Is to Be Sought Where It Lies Buried in Arizona

By D. MOREAU BARRINGER, JR.

MUCH has been written and published about the Meteor Crater of Arizona, but it appears that most people have only a hazy knowledge of the subject at best. This is due, I think, to the fact that the technical publications about it have never had wide circulation; and to the fact that the more popular articles on the subject which have appeared from time to time have often been woefully distorted. It is a subject that seems to challenge the imagination of the average newspaper writer, and several of them have entirely outdone the actual facts in their sensational descriptions of it.

The physical aspects of the Crater are simple. In a flat, treeless plain there is a round hole, surrounded by a raised rim of crushed rock. The hole is about four-fifths of a mile in diameter, and some 450 feet deep, not counting the height of the rim, which rises on an average 120 feet above the plain. This makes the total depth of the hole below the crater's rim about 570 feet.

The geological formations of the region are also simple, being horizontal sedimentary rocks. Except where affected by the impact of the meteorite, they are undisturbed and lie quite level. The surface of the plain is limestone of Permian age, with here and there a few remnants of purple sandstone of the Triassic period remaining on top of it, as little hills. Below the limestone, which is about 250 feet thick, lie a thousand feet of soft, white sandstone, also Permian. The lowest members of this bed have a yellowish or brownish tinge, but the great majority of it is white. Below this lies an indeterminate thickness of hard, red sandstone, quite different in both structure and hardness from the white sandstone above. This is either Permian or upper Carboniferous. For greater lucidity I shall refer to these beds by their local geological names. The remnants of purple sandstone belong to the Moencopie formation; the limestone is the Kaibab limestone; the white sandstone in the Coconino; and the hard, red sandstone below is known as the Supai formation, or more commonly, as the "Red Beds."

Except in the neighborhood of the Crater, these rocks, as I have said, are lying level and undisturbed. Around the edges of the hole, however, they are greatly cracked and broken, and have been raised up so as to slope radially away from the hole in all directions. Those rocks which once occupied the hole itself have been smashed into fragments of all sizes and thrown into the air, from whence some of them fell back into the hole, partly filling it, the remainder being scattered and piled up around the rim.

Mixed with these fragments around the hole and on the plain a short distance from it *there have been found a far greater number of iron meteorites than have been found on all the rest of the earth's surface put together.* And, what is even more striking, the closer you get to the hole the

Science Backs Meteor Crater

Because certain people, reluctant to believe the unprecedented, regard as sensational the theory that Meteor Crater was formed by the impact of a giant meteor which struck the earth, we have obtained the following definite statements from two well-known scientists:

"I am perfectly willing to make a strong affirmative statement in support of Mr. Barringer's article," writes Dr. W. F. Magie of the Palmer Physical Laboratory, Princeton University, "but there ought to be no need for it. There is no reasonable doubt that the Crater was formed by the fall of a meteor and that this meteor is buried in it."

Dr. Elihu Thomson, Director of the Thomson Laboratory of the General Electric Company, writes, "I am very willing to be quoted as follows: 'There can be no question of the Crater being made by masses of meteoric iron, and that an enormous mass of such iron remains buried under the south wall of the Crater.'"

The Editor.

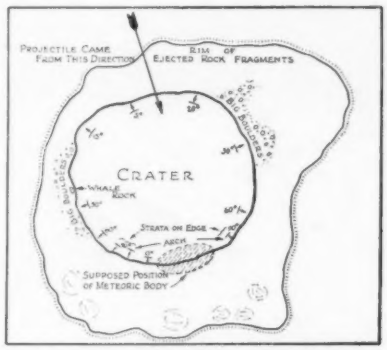
more you find. In other words, the center of the swarm of meteorites and the center of the Crater coincide.

In addition to the solid, metallic iron metorites, there has been found a great quantity of pieces of iron oxide, which by its structure and composition, has been shown to have been derived, by terrestrial oxidation, from meteoric iron. The distribution of these fragments is the same as that of the metallic iron. Both are found intimately admixed with the material excavated from the hole—in other words, *the excavated material and the meteorites got there at the same time.*

THIS is sufficient data on which to advance a proof of the metoric theory of the origin of the Crater. Either the hole was made by a metorite or a cluster of metorites, or else the juxtaposition of the hole and the meteorites is accidental. If accidental, then you have the coincidence of an unprecedented fall of meteorites hitting the same spot on which suddenly appeared an unprecedented crater in sedimentary rocks, and hitting it at the same instant of time in which the crater was made. The chances against such a coincidence are, of course, many billions or trillions to one. Many other proofs of the meteoric theory have been advanced, but this one has always seemed sufficient to me.

It was quite sufficient, also, for my father and the men who were interested with him in the first exploration of the Crater. As soon as they had established not only the coincidence of location of the meteorites and the hole, but also their simultaneity in time, they acquired the property and set to work to find the main mass of the metorite. That was in 1903.

They reasoned (mistakenly, as we now know, for hindsight has a few advantages over foresight) that, since the hole was round, the meteorite must have fallen vertically, and therefore be in the center of the hole. On this assumption they started a shaft at the center of the Crater, from which they expected to run radial drifts, like the spokes of a wheel, when they reached the required depth, until they encountered the mass. They knew that the meteorite had not penetrated



MAP OF METEOR CRATER

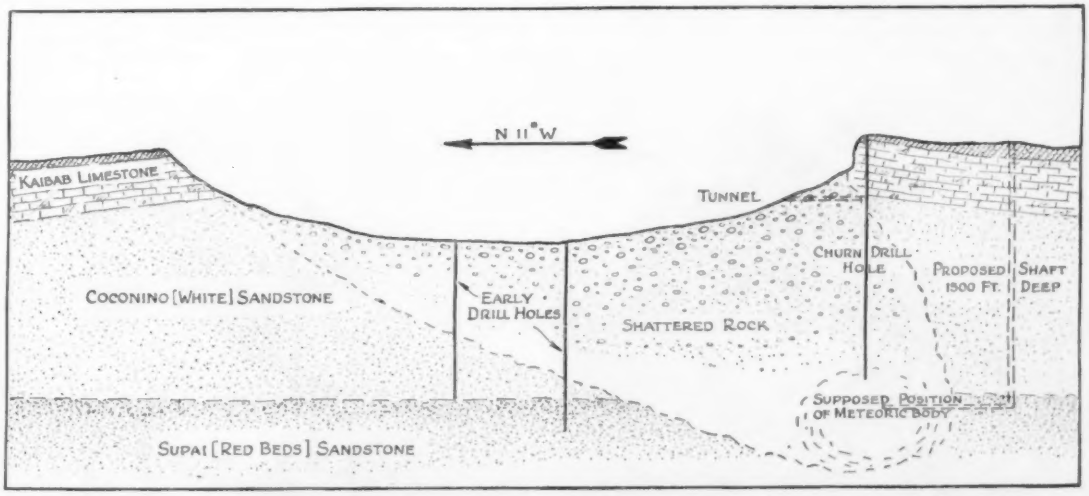
This series of articles will be made much clearer if the reader will study the angle of dip of the strata all around the rim, as indicated by figures on the map. At the north, they are nearly horizontal; on either side they change gradually as the south rim is approached, finally standing on edge; above the buried body they are horizontal again, but this portion was raised bodily 100 feet by the impact, instead of being bent. This part is termed the "arch" by the author

more than 1300 or 1400 feet below the surface of the plain, because no piece of the Red Beds, which lie at this depth, had been thrown out.

But in the shaft at the depth of 200 feet they encountered an unexpected obstacle. A great deal of the soft Coconino sandstone had been so shattered by the impact as to be in the form of fine white dust—so fine that 55 percent of it will pass through a 200-mesh screen. This silica dust became mixed with water in the center of the Crater—for the catchment area of the crater, 4000 feet in diameter, is considerable and collects all the scanty rainfall which falls on it—and had made a quicksand through which they were unable to drive their shaft. Luckily, as we have since discovered, this quicksand is only local and is confined to the central portion.

THE next step was to sink deep drill holes in an effort to locate the mass. Still proceeding on the theory of a vertical fall, they thoroughly explored the central portion of the great bowl to a depth of a thousand feet. This drilling, although it failed of its purpose of finding the mass, did disclose some interesting facts. From the floor of the central portion of the Crater to a depth of some 90 feet, the ground is composed of stratified lacustrine sediments, practically all crushed sandstone and limestone.

From 90 feet down to 600 or 800 feet, the ground is a jumble of large and small fragments of limestone and sandstone, unstratified. This is the material which was thrown into the air at the time of the impact, and immediately fell back into the hole, partly filling it. In this material were found a great number of small specks of oxidized meteoric iron—possibly sparks thrown off by the advancing meteorite. Two very interesting forms of rock were also found in the shaft and in the drill holes, both of them metamorphic products of the white Coconino sandstone. They are known as Variety A and Variety B of the metamorphosed sandstone.



CROSS SECTION OF METEOR CRATER, APPROXIMATELY ALONG A NORTH AND SOUTH LINE

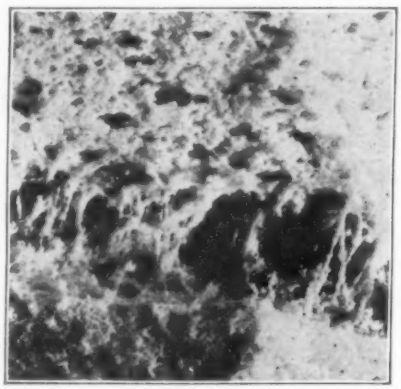
This shows how the meteoric body, thought to be about 500 feet in diameter, smashed its way into the solid rock. The outline of the shattered rock, shown by dashed line, is not accurately known, but the drill holes indicated above, coupled with the knowledge that a paraboloidal hole would be made by the projectile, establish it relatively well

Variety A, (which is also found outside the Crater on the rim) appears, at first glance, almost like the unaltered sandstone. Its structure, jointing, and cross-bedding are quite distinct. But the rock is soft and friable, and a closer examination reveals that nearly every individual sand-grain in it has been so cracked and shattered that it can be rubbed to dust between the fingers or on a piece of glass. One of the workmen aptly termed it "ghost sandstone." The explanation of the phenomenon is not easy, but it would appear that a shock-wave, of sufficient intensity to crack the sand-grains, ran through the solid rock ahead of the impacting meteorite, and ahead of its excavating effect. When the big chunks of sandstone were subsequently broken and thrown out, most of the sand-grains in them were already thoroughly cracked, (like a cracked window-pane that still stay in the jamb) but the structure of the rock itself was practically unchanged. The only major change in the structure was the development of cleavage planes, at various angles to the bedding.

THE second type, or Variety B, of the metamorphosed sandstone, is quite different. Here the metamorphism was due to heat, caused by the friction of the advancing meteorite. This heat was locally so intense as to fuse the silica, and the resulting Variety B is sometimes quite glassy.

Where friction between parts of the meteorite and the rock produced fusion of the latter, one would also expect to find evidence of fusion or volatilization of the former. And this is the case. Here and there, on pieces of the Variety B sandstone, are found yellowish and dark stains of iron oxide, which always give a reaction for nickel. This reaction for nickel, by the way, is used as a conclusive proof of the meteoric origin of the material tested, for all parts of the meteorite carry from 4 to 8 percent of nickel, while no trace of nickel has been discovered in any of the unaffected indigenous rocks.

On the strength of this slight staining by vapors of meteoric iron, it has been suggested by some that the entire mass of the meteorite (some 10,000,000 tons) may have been volatilized by the impact, and so have disappeared. To anyone familiar with the staining powers of iron oxide such a theory is manifestly impossible. Ten million tons of iron, if converted into oxide, could spread a red, insoluble coating, one eighth of an inch thick over more than 300 square miles; or a deposit two feet thick over an area two miles square around the Crater. Instead of any evidence of such staining, we find all the rocks of the region peculiarly white and free from iron, except for the infinitesimal amount of the Variety B which is discolored in the way I have described.



VARIETY B

Appearance of the metamorphosed sandstone, produced by the terrific friction of the meteoric body as it passed through the sandstone

Both Variety A and Variety B of the metamorphosed sandstone present additional proofs of the meteoric theory. The shattered sand-grains of Variety A clearly show the effect of a sudden terrific blow, rather than the effect of any volcanic explosion. The same is true of the millions of tons of "rock flour"—that is, finely pulverized sandstone which forms part of the rim and crater.

But to continue with the drill holes. At depths ranging from 600 to 800 feet, the drills encountered solid sedimentary rock, bedded horizontally, and showing no effects of alteration since the late Paleozoic geologic time when they were laid down in the sea. At a little below 800 feet, the Red Beds sandstone appeared, in place and entirely unaltered. One drill went over 100 feet into this standstone and, of course, found no evidence of alteration there. Seven drill holes sunk in the central portion of the Crater entered the Red Beds sandstone and all showed it to be in place and unaffected by any agency.

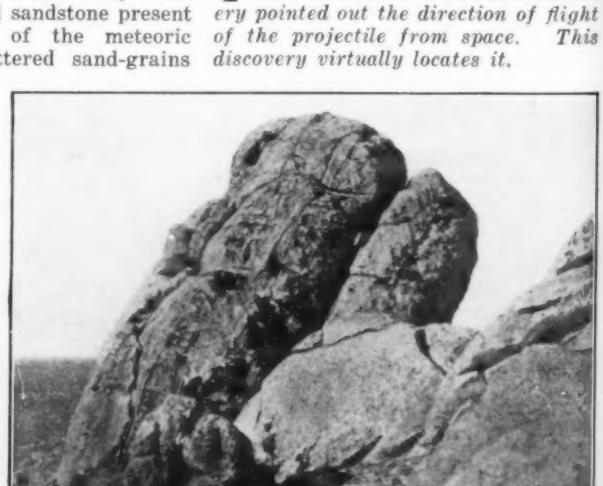
HERE were two important pieces of information. Finding the depth of the Red Beds gave pretty accurate information as to the depth at which the meteorite must lie buried, and finding the rocks unaltered below that depth gave additional proof that whatever caused the hole came from above and not from below. No volcanic or steam explosion could have caused all that havoc in the overlying rocks without disturbing the beds beneath.

But although these drill-holes furnished a lot of interesting and useful information, still they failed to disclose the whereabouts of the meteorite. And, furthermore, they used up most of the funds available for the search, so that work was suspended. That was in 1908.

¶ *In the next issue Mr. Barringer will tell how an accidental discovery pointed out the direction of flight of the projectile from space. This discovery virtually locates it.*

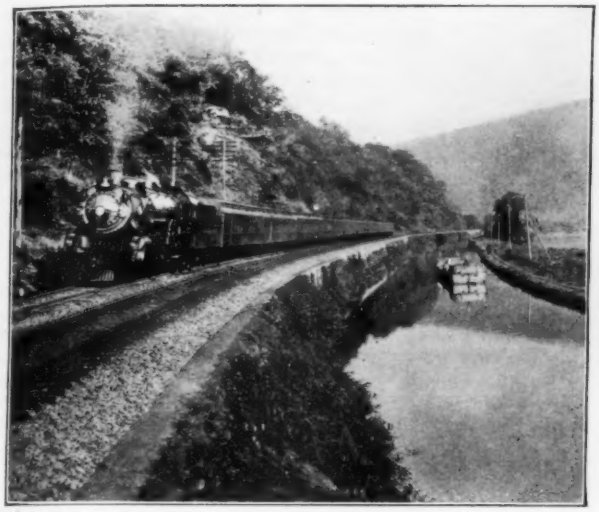
CRUSHED AND PULVERIZED SANDSTONE

This is the rock flour, exposed in a stream cut, which is abundantly found in the crater. It is described in the text



THROWN OUT BY THE SUDDEN IMPACT

"Whale Rock," mentioned in the article. Its position is shown on the map, page 53. Note the Mexican's hat in the picture



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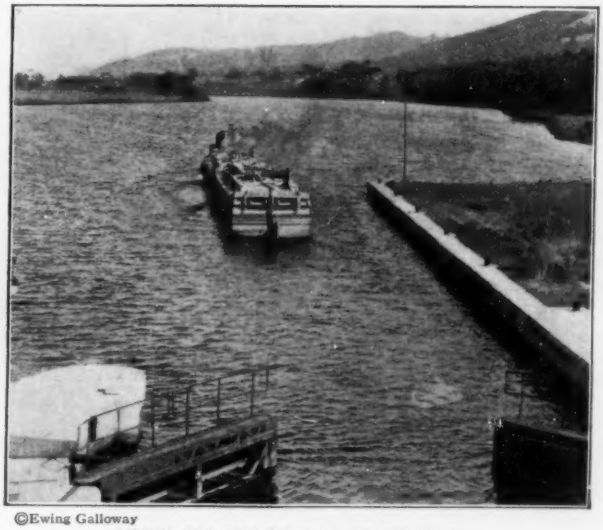
THE OLD AND THE NEW

A lovely stretch of the old Chesapeake and Ohio Canal beside the Potomac. The first surveys were made by George Washington



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VIEW ON STATE BARGE CANAL

Two grain barges on the State Barge Canal (Old Erie Canal) leaving Lock Number 9 near the town of Amsterdam, New York

Uncle Sam, Spendthrift---XI

Failure to Develop and Deepen Our Lake and River Systems Causes an Enormous Economic Loss

By J. BERNARD WALKER

MANY an American who has journeyed through Europe with an observant and unprejudiced mind must have noted how extensive are the canal systems of Europe, and what an abundant use is made of the inland navigation facilities thus afforded. He may have memories of a trip up the Rhine, and not the least permanent of all impressions is that of the stream of barges of large size that moved in continuous procession up and down that busy waterway; and the same conditions may be noted all over Europe. The dam and the dredge have done their work; banks have been raised and entirely new connecting canals cut at strategic points. It appears to the traveler that much of the continent of Europe is net-worked with canals that are teeming with traffic.

In returning to America, with these impressions still strong in the traveler's mind, he must have been struck with the magnificent liberality with which Nature, by means of lake, river and stream, has provided immediate or prospective waterway systems. If so, his admiration was tempered with the thought that America, for all her shrewdness, intelligence and activity, has practically failed to make use of the promising transportation facilities thus provided.

Oh yes, we have some canals and we have done some dredging; but the work has been done in a haphazard, desultory way, without any broad-visioned plan or any ordered, continuous work. The vast floods, which at the hour of writing are spreading desolation throughout the Mississippi Valley, are chargeable to the fact that the work done has been "spotty," both as to time and locality. Had the money which has gone into the Mississippi River improvement been spent where and when the United States Engineers Corps directed, the levee protection of the river would today be an accomplished fact, and the mighty flood would be moving quietly within its predetermined and amply-protected channel.

LOCK ON WELLAND CANAL

This canal (30 feet on lock sills) will pass shipping around Niagara Falls

We ask the reader to consider here, and very briefly, some of the magnificent waterway facilities of the United States which need only the hand of the skilled hydraulic engineer, and—in view of the enormous economic conditions to be obtained—a moderate expenditure of capital, to give them rank among the great transportation facilities of the country. First in importance, we place the construction of a shipway from the Great Lakes to the sea; the deepening and control of the Mississippi River; similar work upon the Tennessee, the Arkansas and Rio Grande Rivers; and particularly upon that noble stream, the Columbia River in the northwestern part of this country.

The opening up of a seaway through the St. Lawrence River for ocean-going ships is, of course, intimately tied in with the raising of the lake levels and the deepening of the channels leading to the various great inland ports. The whole question has been most carefully studied by the United States Engineers Corps; the main facts of the situation—considered as an engineering problem—and the practical way to meet them, are

well known and have been clearly explained in various government reports. Enthusiastically back of the proposed seaway is the Secretary of the Department of Commerce, Mr. Hoover, who is himself an engineer of world-wide reputation.

AS regards this Great Lakes-to-the-sea project, the first problem to be solved is the raising of the lakes to a predetermined level and their permanent maintenance at that level. Hitherto, this problem has been in the hands of the politicians, and under their benign guidance, the various states and cities in the lake region are engaged in an unseemly squabble, upon which to date there has been spent a sum of money which would have sufficed to build the simple regulating works which would solve the problem of levels overnight. The United States Engineers' plan calls for the building of certain submerged weirs, notably at the Lake Erie entrance to the Niagara River and at the entrance of Lake Huron to the Detroit River. The Great Lakes provide the finest inland transportation system in the world, but traffic which seeks to pass to the sea must go through "bottle-necks" of 11 and 12-foot canals.

Three deep-sea canals have been proposed. One is from Lake Ontario to the Hudson by way of the new Welland Canal between Lake Ontario and Lake Erie. Another calls for developing a so-called "all-American route" which, in addition to the Lake Ontario-Hudson project, would build a new ship canal in American territory along the south side of Niagara, a costly work which, in fact, would be a duplicate of the Welland Canal. The third—and to our thinking the most sensible and unquestionably the cheapest route—would be to deepen the

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A LOCK ON CHAMPLAIN CANAL

The Lake Champlain Canal is one of the important tributaries of the New York State Barge Canal

St. Lawrence River by means of dams —this last to be a joint undertaking of the United States and Canada.

As regards the St. Lawrence route, the locks of the Welland Canal have been built with a depth of 30 feet to enable the canal ultimately to carry that depth throughout. If an immediate depth of 25 feet is adopted, it will permit the passage of 88 percent of all ships that now enter American ports, and its estimated capacity is 30,000,000 tons per annum.

The report of the United States Engineers of December 6, 1926, estimated the cost of the Lake Ontario-Hudson route at 506,000,000 dollars; of the all-American route at 631,000,000 dollars — and neither of these routes will offer any returns by the development of water power. The net cost to the United States and Canadian Governments of the St. Lawrence route is estimated by the joint engineers of the two governments as between 123,000,000 dollars and 148,000,000 dollars. As regards the hydro-electric power which would be derived from the great rapids which now obstruct river navigation, the commission estimates that the complete practical power development of the river will reach a total of about 5,000,000 installed horsepower.

Now, the opening up of the ports of the Great Lakes to direct ocean-going traffic between them and ports of the world is a matter of huge economic interest to the 18 states which represent that portion of the country adjacent to the lakes and which would be served by such a Great Lakes system. A sufficient answer to the question "why are these states of the mid-west so enthusiastically in favor of building the St. Lawrence Canal?" is to say that this improvement will decrease the costs of the export of grain by seven to eight cents a bushel. Not only will this decreased charge lower the cost to the farmer of reaching his foreign market, but it will be a definite addition to the farmer's profit. Furthermore, it will make possible the introduction of the manufacturers' raw materials to the interior states on a much cheaper basis.

AS the matter now stands, all foreign shipments of agricultural produce have to be taken to the nearest port on the seaboard, either directly by rail, or by combined rail and lake shipping, with a second transfer from lake to rail for the journey to the seaboard.

In this connection, we invite attention to the accompanying map, showing the position of the eighteen states and their cities with reference to Lake ports and to Atlantic and Gulf ports.

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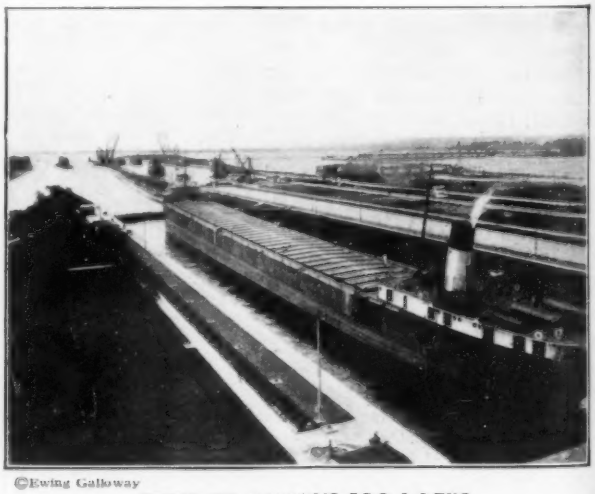
A 2000-TON STEEL BARGE

Twin Ports, a Diesel-engined steel barge, running by way of Great Lakes Barge Canal from Duluth to New York



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VIEW OF FAMOUS SOO LOCKS

Soo locks at the entrance of Lake Superior to the St. Claire River, shown with a typical iron-ore steamer in transit

When the St. Lawrence Ship Canal has been built, the various lake ports will be able to load, let us say grain, direct for Europé as is now done at the ports on the seaboard. The greatly improved position of the shipper as regards the cost of rail transportation is shown by a study of the figures in the various circles. These represent, in the upper half of the circles, the rates in cents per 100 pounds from those points to Chicago, Toledo and Cleveland, and in the lower half the present rate in cents per 100 pounds by rail to the Gulf and Atlantic ports. This map surely vindicates the widespread enthusiasm with which the midwestern states are working to secure the construction of the St. Lawrence waterway.

THE great basin of the Mississippi presents ideal conditions for water-borne traffic. Mr. Hoover tells us that here we have a drainage "upon which for moderate cost we can provide a modern transportation system of 9,000 miles of connected waterways, serving 20 states and furnishing a complete north-and-south trunkline from Duluth through Chicago to the Gulf of Mexico, and an east-and-west system from Pittsburgh to Kansas City." Would it pay? Most certainly. The stretch of the improved Mississippi from St. Louis to New Orleans has proved that modernized, water-borne service can successfully reduce the costs of transportation of commodities in bulk to pre-war rates. Similarly, on a proportionate scale, the development of the Tennessee and Cumberland Rivers would not only provide about 3,000,000 hydro-electric horsepower, but the cities of Nashville and Chattanooga would be afforded adequate water transportation. Similar benefits would follow upon the control and development of the Arkansas River.

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LAKE PONTCHERTRAIN CANAL

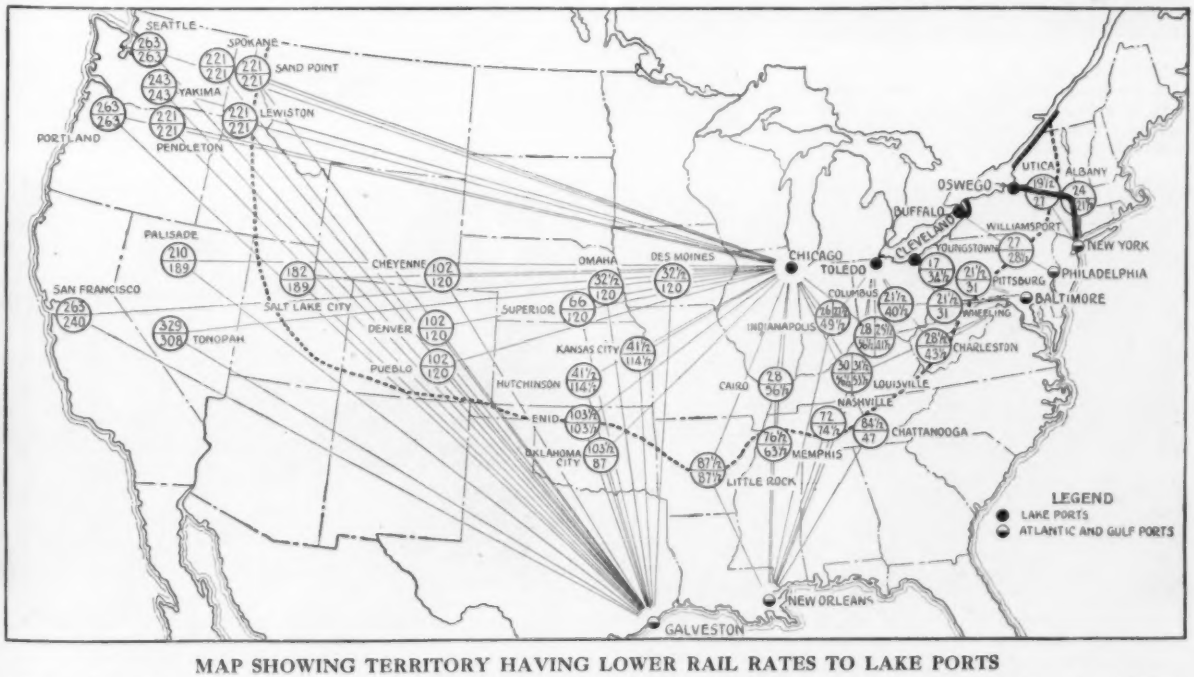
Bridge over the new navigation canal connecting the Mississippi River with Lake Pontchertrain. This fine waterway provides New Orleans with a large, sheltered anchorage basin

Of what could be done on the Rio Grande we have spoken in the previous chapter of this series. Furthermore, in any great national program, such as we now advocate, the great Columbia River should hold a foremost place. In this river, 3,500,000 horsepower await development, and through the basin there is flowing sufficient water for the cultivation of 1,800,000 acres of rich soil, to say nothing of other minor but still important projects. The putting through of this work will also provide that region with a great extension of the present rather limited water-borne traffic.

The Columbia Basin project has been made the subject of three surveys by a commission of engineers of the State of Oregon; by General George W. Goethals; and by a board of engineers of the United States Reclamation Bureau. All have pronounced in its favor.

IF the present rate of growth of population continues, there will be added, during the next quarter of a century, some 40 million people to our population. To provide for the needs of the future, as thus vastly increased, we must either build more railway trunkline systems or we must carry out the waterway improvements mentioned above, so they may take their share of the burden. To build new railways of the capacity of the proposed new waterways would mean the expenditure of three times as much capital.

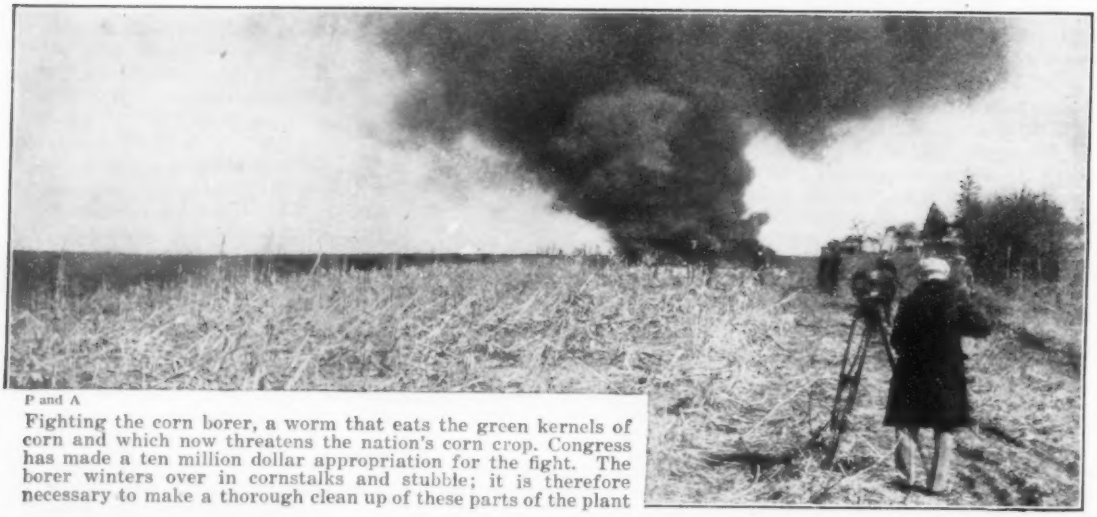
¶ *Growing oysters on trees! This is not a joke, but is a method of increasing the crop of bivalves. This method will be described in a future issue of this magazine.*



MAP SHOWING TERRITORY HAVING LOWER RAIL RATES TO LAKE PORTS

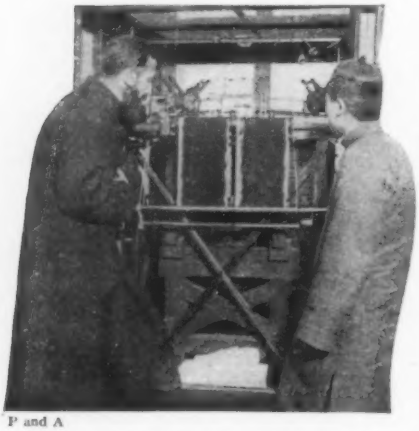
The territory that will be benefited by making deep-sea ports out of Great Lake ports is indicated by the heavy dotted line. Rates shown in circles are first-class domestic rates, in cents per 100 pounds; upper figures rates to Lake ports, lower to seaboard ports

From the Scrap-book of Science —



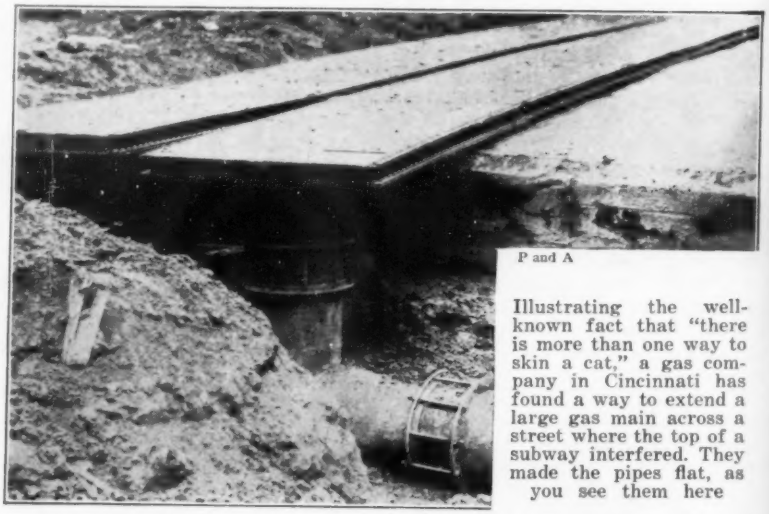
P and A

Fighting the corn borer, a worm that eats the green kernels of corn and which now threatens the nation's corn crop. Congress has made a ten million dollar appropriation for the fight. The borer winters over in cornstalks and stubble; it is therefore necessary to make a thorough clean up of these parts of the plant



P and A

Father Gherzi, S. J., at the Jesuit Observatory in Shanghai, China, with the Wiecher astatic seismograph. The Jesuits incline rather strongly to science, especially earthquake science

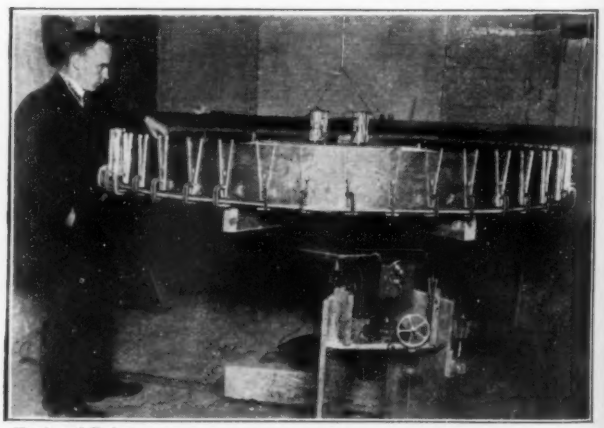


P and A

Illustrating the well-known fact that "there is more than one way to skin a cat," a gas company in Cincinnati has found a way to extend a large gas main across a street where the top of a subway interfered. They made the pipes flat, as you see them here

Wide World

A room has been installed in the University of Pennsylvania Hospital, Philadelphia, for the study of bronchial asthma, allergic colds and hay fever. To exclude all undesired impurities, the air is washed. Substances suspected of causing the trouble, especially house dusts, are then introduced into the room



Harris and Ewing

Apparatus which is being used by Mr. Carl Rosby, Swedish scientist working at the United States Weather Bureau, for making model experiments of atmospheric movements by means of liquids of different densities. In Scandinavia the theory under which this apparatus works is being used for weather prediction

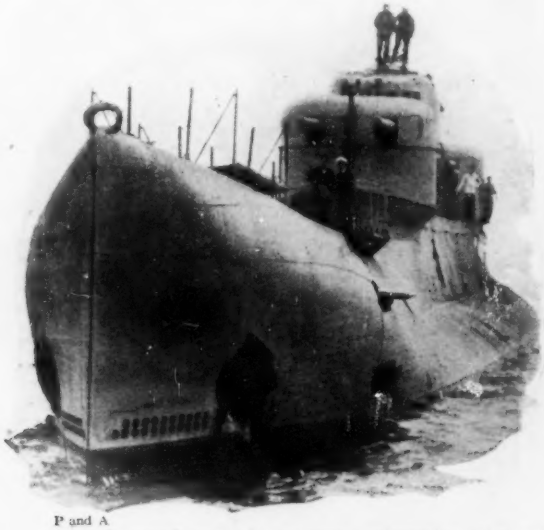
Camera Shots of Scientific Events

P and A

Virtually a submersible cruiser is this new, giant British submarine of 3600 tons displacement. It carries four 5.2 inch guns, can make 22 knots (25.3 land miles) per hour when not submerged, and carries a crew of 120 men. It has sufficient speed to overtake and capture merchant vessels of more than ordinary speed

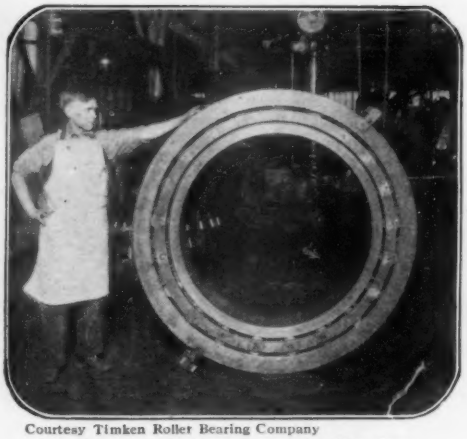
Alfred Schnitker of Cincinnati has built an interesting five cylinder airplane engine of three and one quarter inch bore and three and one half inch stroke, making 3800 revolutions per minute. The wide angle between the cylinders permits better ventilation

P and A



P and A

The forward end of the same submarine, the XI, shown at the top of the page. Her bulbous raised bow is for buoyancy when running on the surface; thus when running into head seas she will rise over the waves instead of cutting through them



Courtesy Timken Roller Bearing Company

The largest Timken tapered roller bearing ever built. Its bore is 42 inches. At 30 revolutions per minute, it carries 2,750,000 pounds. It weighs over two tons

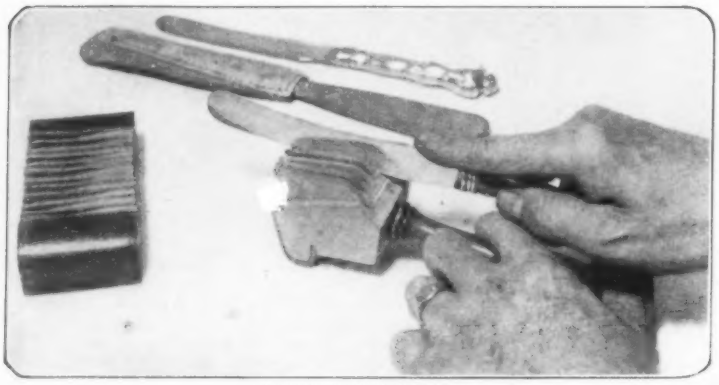
Wide World

Insects that live on books will find life not worth living when library books are made of a new kind of "bug-proof" paper invented by William R. Reinicke, Librarian of the Apprentices' Library in Philadelphia. Mr. Reinicke is showing samples of the work of "bookworms"

Household Inventions

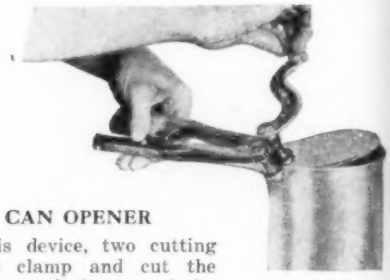
Devices Illustrated on These Pages Make Housework Easier

CONDUCTED BY ALBERT A. HOPKINS



KNIFE POLISHERS

The devices to the left and in the center have felt strips, between which the knife blades are drawn for polishing. The one in the background is to be used for polishing raised surfaces on handles and the like



CAN OPENER

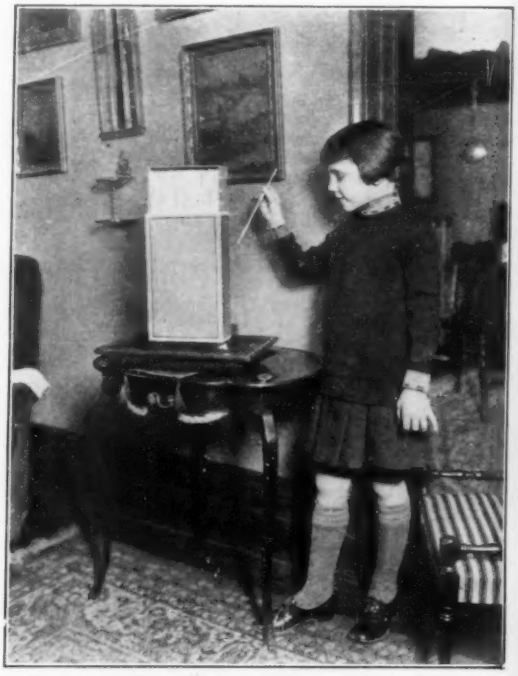
In this device, two cutting rollers clamp and cut the bead around the top of the can and bend the edge under, preventing the possibility of injury to the user

COFFEE STRAINER

The handy wire utensil at the left, for use in the kitchen, is fitted with a small piece of muslin or gauze for straining coffee, tea or other liquids. The filtering material can be changed quickly ◄

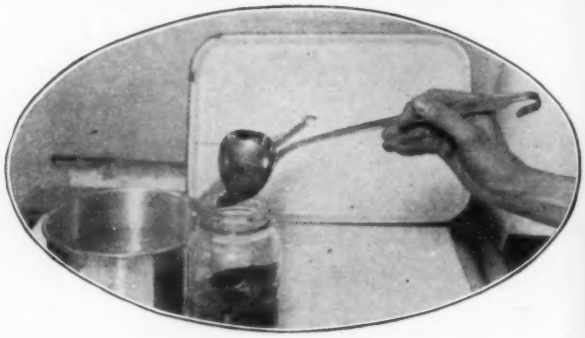
FIRE LIGHTER

The enormous matches at the right are really matches in every sense of the word. They are to be struck on the box and used for lighting fires. Because of their large size, they are long burning. ►



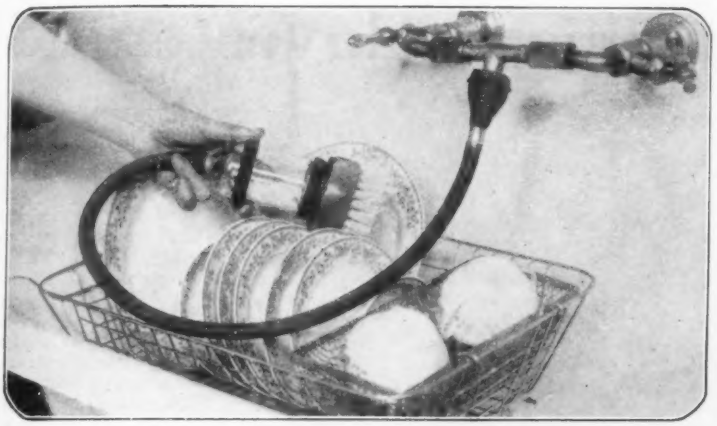
EGG LIFTER

This is the same device illustrated in the left center of this page. Here no cloth is used, as the implement is being employed to remove eggs from hot water. It has many other uses in the kitchen as well as those shown



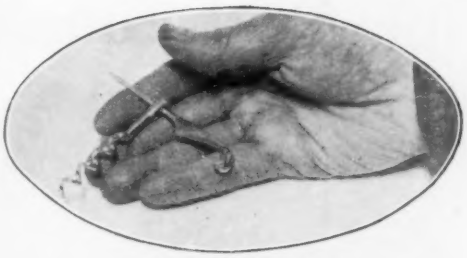
POURING LADLE

The shape of this large spoon makes it possible to guide fruit, liquids, et cetera, directly into the mouth of a vessel, eliminating spilling



DISH WASHER

Small pieces of soap are put in the glass container, the hose is attached to the hot-water faucet, and the soapy stream directed on the dishes



BOTTLE OPENER

This combination corkscrew and crown-cap remover comes from England. It is separable, the handle of the corkscrew being removable from the corkscrew shaft

TAPE MEASURE

The imitation clock is a spool that holds a rolled-up tape measure. The hands revolve as the tape is pulled out, registering the number of inches that the tape extends from the holder

KITCHENETTE

This complete kitchen can be installed in a space five feet, six and one half inches long. Every possible convenience for cooking is included here

CORK PULLER

The French novelty illustrated above will remove corks from bottles, even when fitted tightly. The "lazy-tongs" arrangement allows the exertion of a large force directly upward from the bottle mouth, thus extracting the cork without trouble

CLOTHES CLEANER

The receptacle above the brush in the device at the left holds gasoline, naphtha, or similar cleaning fluid, which is applied to the clothes as they are being brushed thoroughly

SPOON POLISHER

A soft cloth or piece of chamois covers the end of the device illustrated at the right. It is intended for use in polishing the bowls of spoons as shown

With the Automotive Inventors

AID TO PARKING

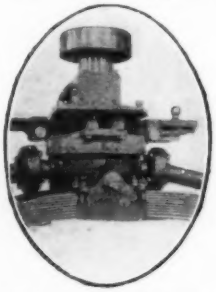
The problem of finding parking space in large cities is becoming one that demands serious thought. If the amount of space required for each vehicle while standing at the curb can be reduced, the result will be that more of them can be parked in a single block. This is what the device illustrated at the left purports to do. A set of four small rubber-tired wheels are mounted on extensible carriages in the under part of the chassis. These are worked through a special gearing arrangement connected to the regular transmission, and when actuated, the regular wheels of the car are raised off the ground. Power may then be applied to the four small wheels, and the entire car moved either to the right or left as desired, thus enabling the driver to park in a small space

ROADSTER-TRUCK

For the purpose of converting a light roadster to a small truck, the body illustrated at the left and right has been designed. This consists of a steel box arranged to run on a channel-steel frame. The rear end of the box replaces the regular body-end. When the car is to be used as a truck, the box may be pulled out and locked in any position

FRONT-END DRIVE

A novel front-end drive for all types of automobiles has been devised by a New York inventor. Because of the spring suspension, and the fact that the axle swings with the front wheels when steering, the vehicle can be turned in a very small circle. The front of the chassis is suspended by only one point; the resulting three-point suspension gives stability

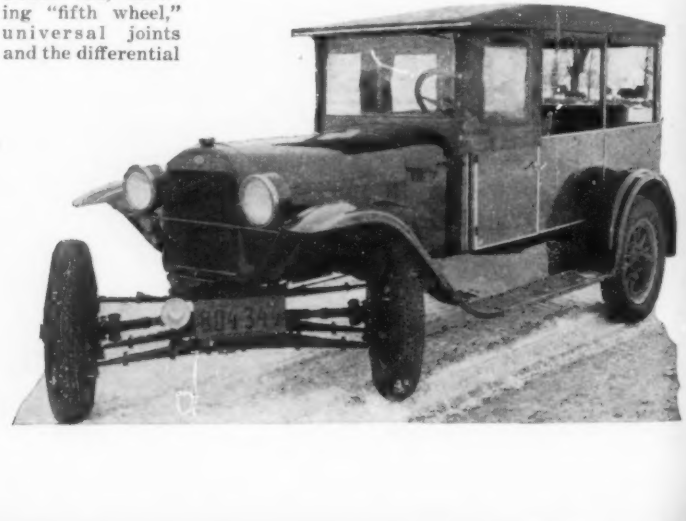


THE MECHANISM

Front end, showing "fifth wheel," universal joints and the differential

ROUNDING A CURVE

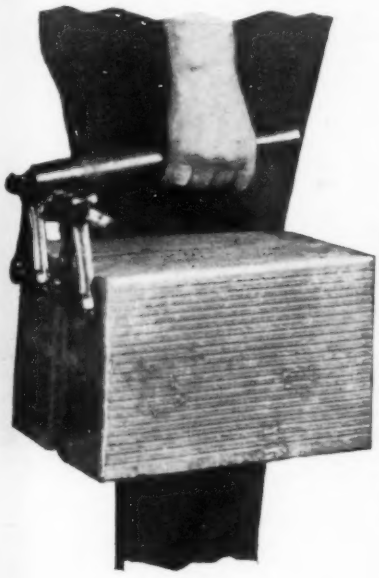
The photograph reproduced below shows the front-wheel-drive car with the wheels turned for executing a sharp curve. With this automobile, it is said that there is less road vibration transmitted to the steering wheel. This is due to the spring suspension, which consists of one half-elliptic and two quarter-elliptic springs. The car will over-ride obstructions with a minimum of twisting of the chassis because of the suspension method used



Inventions in the Engineering Field

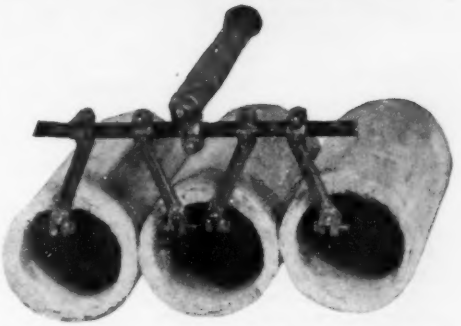
MOVING LARGE PIPES

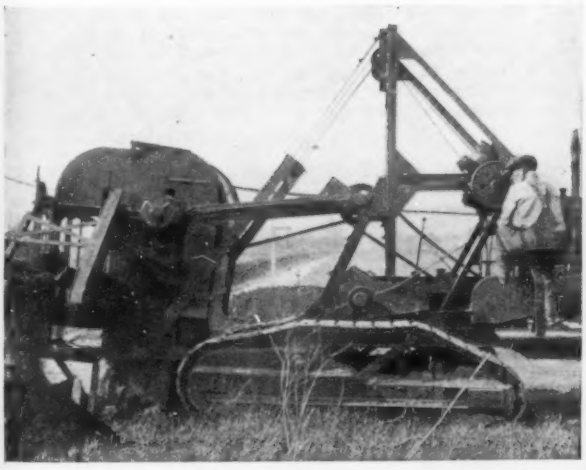
The problem of moving seven-ton sections of sewer pipe proved to be a large one to the engineers of the Western Concrete Pipe Company, until the idea illustrated at the right was hit upon. A length of comparatively small iron pipe was inserted through the concrete pipe, a disk was placed at each end and chains were used to attach the iron pipe to a tractor. When the machine was started, the iron pipe engaged the inner surface of the concrete pipe and the latter rolled along after the tractor. The disks at the ends of the iron pipe supported it



PIPE CARRIER

In the present day scheme of building, concrete and tile pipes and blocks play a large part. When loose and being handled on the job, their fragility and awkward shapes are great drawbacks. To eliminate this, the adjustable device illustrated at the left and right has been invented. This is a simple carrier that can be changed in size so as to accommodate either square or cylindrical shapes. A handle is provided, and it is so placed that the workman's hand can grasp it just over the center of gravity, thus making the load balance easily and eliminating the possibility of the pipes slipping off the carrier. As clearly shown at the right, the arms that slip within the pipes or blocks are held in place by bolts and nuts and so, once set, the carrier can be used on the same size pipe throughout the job





DITCH AND POST-HOLE DIGGER

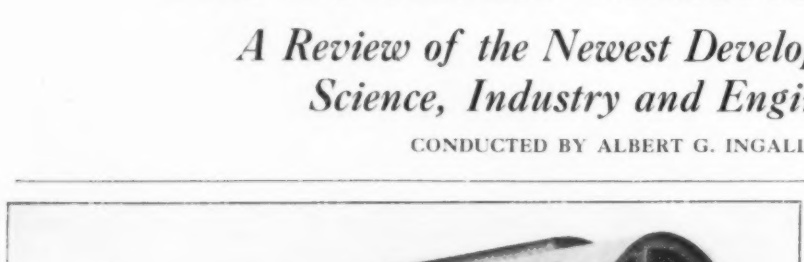
A ditching machine that digs either straight ditches or vertical holes for locating pipe joints or doing other service work has recently appeared on the market. The photograph above shows the machine in operation digging a square vertical hole. Because of its construction, it can be operated close up against the curb

The ditch digger is shown in operation in the above illustration. The caterpillar bands transmit the motive power, and a discharge for the dirt is placed so that the material is piled to one side. An ingenious construction of the digging buckets makes it impossible for them to be damaged by encountering obstructions

The Scientific American Digest

A Review of the Newest Developments in Science, Industry and Engineering

CONDUCTED BY ALBERT G. INGALLS



The "Paragon" 400-horsepower thermo-electric freight locomotive

A British Diesel-Electric Locomotive

THOSE who have followed with interest the comparatively recent developments leading to the use on some of our railroads of Diesel-electric locomotives, chiefly for switching purposes, will find further interest in the following description of a British locomotive of that variety, sent us by Mr. F. C. Livingstone, of London:

"One of the most difficult problems associated with the development of railway electrification on a large scale, is that of providing an electric locomotive suitable for main-line railways equipped with either a direct or alternating current supply. With this objective in view, a vast amount of experimental and technical research work has been carried out during recent years in America and in Europe. What is known as the 'Paragon' thermo-electric freight locomotive can be used with either steam, gasoline or oil as prime movers.

"Each axle of this locomotive is driven by a special 85 brake-horsepower, direct-current electric traction motor, through the medium of a worm drive. This worm reduction gear is claimed to be the strongest mechanical reducing power, while it also permits the motor to be placed longitudinally with the main frame.

"The generating plant is carried on the locomotive and consists of a 400 horsepower, six-cylinder, two-stroke, heavy-oil engine running at 500 revolutions per minute. This engine is of special design for locomotive work and is fitted with an altitude compensating device, which permits the locomotive to give full tractive effort even at an altitude of 15,000 feet above sea level, where the ordinary types of internal-combustion locomotives fail to deliver their sea-level power owing to lack of atmosphere pressure. Current is generated by means of an electric-kinetic transformer driven by the oil engine. The armatures of the transformer form the necessary flywheel effect for the engine. The weight and cost are reduced by the absence of the common flywheel, which is provided for by heavy roller bearings fitted at each driving end of the engine to carry the armature.

"The starting power is provided for by running the electric transformer as a powerful electric starting motor. The current, which is needed only for a few seconds, is provided by a small storage battery, which is automatically charged from the primary side of the transformer when the main engines are running. This storage battery also supplies the power for the lighting and other auxiliary power work.

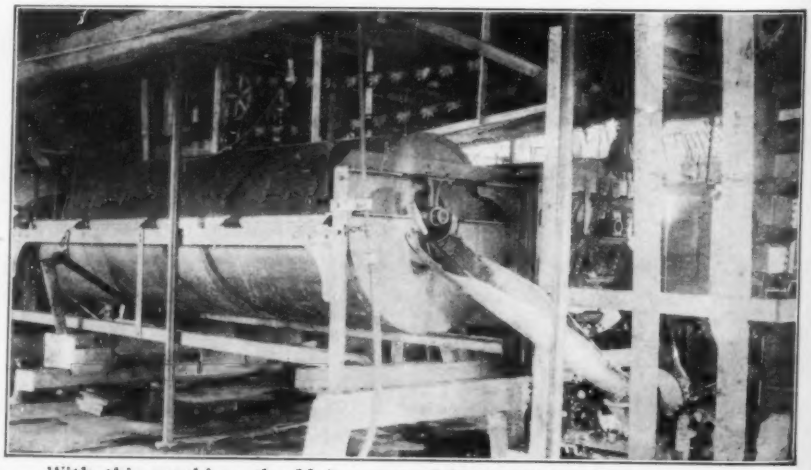
"The locomotive is fitted with two coolers, one at either end. These draw the air in at the center and, by means of a variable speed, electrically-driven turbine-type fan, the heated air is thrown out radially, thus preventing road dust from being blown into the machinery in the locomotive cab. The coolers are of strong construction and are fitted with copper tubes, the whole being tested to 120 pounds per square inch working pressure.

"The locomotive, which weighs 43 tons when in full working order, has a starting tractive effort of 10,000 pounds and a maximum speed of 26 miles per hour. The length of the locomotive over all is 33 feet, six inches."

Effective Blueberry Cleaner Invented by United States Chemists

A CONSIDERABLE portion of the Maine blueberry crop was saved from destruction last season by a process invented and patented by B. J. Howard and C. H. Stephenson of the Bureau of Chemistry, United States Department of Agriculture. The use of this process prevented great losses to the growers of Maine blueberries and made it possible for consumers everywhere to obtain the usual quantity of the delectable blueberry pie. The patent, which has been dedicated to the people of the United States so the process may be used without the payment of any royalties to the inventors, covers a process for effectively removing maggots, debris and unfit berries.

Only clean, sound berries free from maggots may be canned and sold within the jurisdiction of the Federal food and drugs act. The blueberry maggot develops from the egg of a little dark fly,



With this machine, the Maine crop of blueberries, badly infested with maggots, was saved. The machine sorts out the maggots and all of the defective berries at a rapid rate

somewhat smaller than the common house fly. When it was learned that a portion of the crop of blueberries was infested with maggots, it seemed for a time that a large part of the crop might be a loss, since there had been no practical method available for separating the unfit from the sound berries. Messrs. Howard and Stephenson, who had been detailed during recent seasons to study the problem, developed the effective process which has been patented. This process was used with great success during the last canning season by nearly all the canners in the areas where there were infested berries. By separating out the maggoty and otherwise unfit berries, the bulk of the blueberry crop which was sound was saved and rendered suitable for canning. The patented process is not only effective but also comparatively cheap.

The object of the invention is to remove maggots, maggot-eaten and otherwise defective blueberries through the controlled action of water and the mechanical crushing or grinding of the blueberries on each other. This is based upon the fact that blueberries containing maggots or that may be partially decayed are generally more easily broken open than the uninfested and sound berries, and the broken or crushed berries are removed in the process. The berries are revolved in hollow cylinders covered with suitable screen so constructed as to revolve freely, partially submerged in tanks of water, the level of water being maintained automatically at any desired point. An adjustable overflow discharge pipe which drains from the bottom of the water tanks, secures a constant level for the water and also an effective means for removing continuously the objectionable berry debris which tends to settle to the bottom.

One machine will treat effectively 350 to 500 bushels of berries in a day. The amount varies greatly according to the condition of the fruit. It is the general opinion of the canning trade that as a result of the use of this process during the last canning season, a considerable portion of the blueberry crop was saved from total loss.

One million dollars worth of blueberries are canned in Maine in some seasons. In one county of Maine, the blueberry crop is the chief source of income of a considerable portion of the people.

Courtesy *Illustrated London News*

Right: A scale model of the revolving house, which was displayed at a home-building exhibition in France. This house, and the reasons for its features, are described in the text below

French Architect Designs Revolving House

A DWELLING house mounted on a turntable so that any of its eight sides may be quickly swung to face the sun or the summer breeze, is the solution of one common difficulty in the design of homes that has been worked out by two French architects, Georges Lecuyer and Henry Jubault. This dwelling, described in a recent issue of *L'Illustration* (Paris), is not a mere "stunt" but is a practical home of seven rooms, with bath. It is octagonal in shape. By means of an electric motor of four horsepower, it may as easily be swung around as a locomotive is revolved on a turntable.

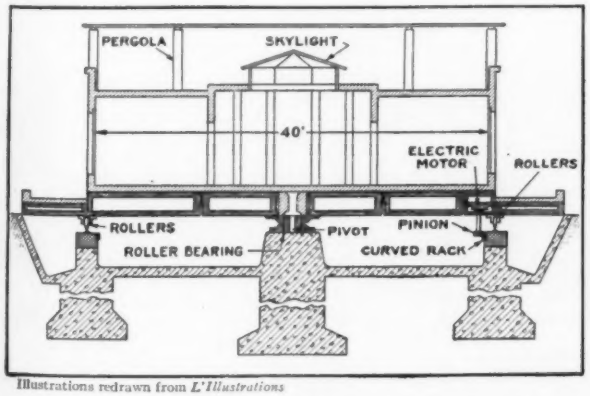
Tournesol, or "sunflower," is the fitting French name given to this odd dwelling, which, *L'Illustration* states, "was designed in an hour of revery." Completed, it has recently been shown at the exhibition of habitation and decorative arts—evidently a sort of "Own Your Own Home" show—at Nice. With a diameter of about 40 feet, the sunflower house is no toy; it is a real house, although the French journal from which we abstract its description calls it "a veritable plaything of the multi-millionaire." Completely furnished, it cost about 250,000 francs — a "before the war" price of about 50,000 dollars.

The whole house, built of steel and concrete, is carried on eight steel girders which radiate from a central pivot. Each girder rests, at its outer end, on a wheel rolling on the track of the turntable. Near the circular track is a curved rack. A pinion driven by the electric motor runs on this rack, rotating the house. One presses a button inside the house; the house begins turning. Another pressure; it stops. The four-horsepower motor will give it one complete turn in an hour.

At the center, the house pivots on a vertical pin equipped with roller bearings. The other details are quite clearly indicated in the illustrations.

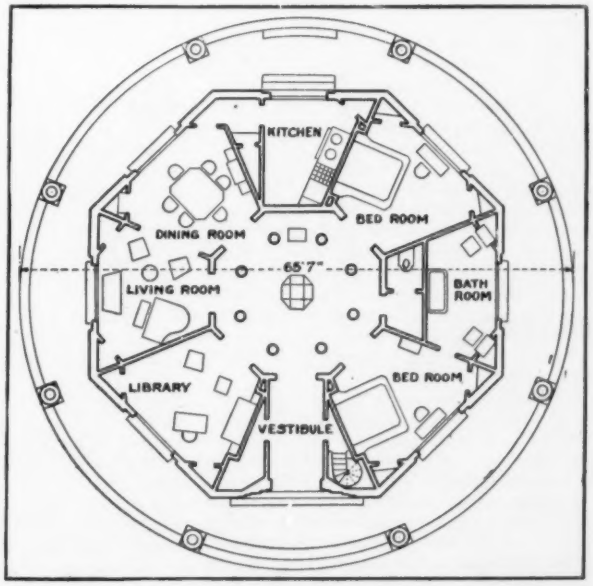
Fluid Fuel From Coal, The Latest Miracle of Synthetic Chemistry

"GASOLINE to be obtained direct from coal;" "A new process for 'liquefying' coal;" "German chemist discovers way to turn coal into gasoline"—these are some of the interesting newspaper headlines all of us read last fall and winter. We wondered how much of it was true. Fortunately, it was nearly all true, and scientists as well as industrial engineers believe a new industrial era is impending because of these recent discoveries. Not all sensational reports about science are to be scouted. In fact, most really great scientific and industrial advances have been sensational, (but not all sensational announcements are scientific!).



Illustrations redrawn from *L'Illustrations*

Above: A sectional plan of the French revolving house. Here are shown the positions of the electric motor, the driving shaft, the pinion and the curved rack. Note the supporting rollers and bearings



Right: This plan view of the revolving house shows the location and shape of all of the rooms. Notice the completeness of the equipment and the accessibility of all the rooms from the central, circular "hall"

Today there is a great hum in the scientific-industrial world, a hum which is likely to reach the public in larger volume within a few years, when the facts have trickled down from the "inner circles" of the experts to the rest of the world. Coal is the source of the hum.

Wide World

Prominent scientists at the Pittsburgh Conference on coal. Left to right: Dr. Oshima, Director Imperial Fuel Research Institute, Japan; Dr. A. C. Fieldner, Chief Chemist United States Bureau of Mines; John Hays Hammond, famous mining expert; Frau Bergius and Dr. Frederich Bergius, inventor of the famous "berginisation" or "liquification" process for coal

We have been merely burning our coal. Now, it becomes evident, burning coal is a wasteful, backward and altogether shortsighted way to treat it. Coal contains just exactly the chemical elements —carbon, oxygen, hydrogen and nitrogen—needed to make no end of other products which the world greatly needs. The trick is, first, to unscramble these four elements from coal; second, to recombine them in the proper proportions. This is what chemists are now beginning to do and it is why we dare state our belief that a new industrial era impends.

The occasion for most of the newspaper comment on "liquifying coal into gasoline," was the so-called and already famous "Pittsburgh Conference," held last November. This brought together from the whole world 1700 of the world's most capable fuel experts. The exact name of the conference was "The International Conference on Bituminous Coal." Here the great and interesting projects centering about the modern manipulation of the elements contained in coal were discussed for four full days. The Conference, it is already seen, was pivotal in the sense that it brought to a head a number of extremely important fuel developments.

Scientist after scientist delivered descriptions of new processes for performing modern miracles with coal, and the occasion for this note, several months after the event, is that the full report of the Conference, a book of 800 pages embodying each speaker's exact words, has at last been published by the Carnegie Institute of Technology, at which the Conference was held. This report actually forms a technical treatise on practically all the newer strides in the chemist's discoveries with regard to coal, and if the mail inquiries we have received since the subject appeared in the newspapers is any gage of their desires, we are certain that many of our readers will wish to obtain it. In effect, by reading this notable work, the reader may attend the Conference, for the papers are published just as they were there presented.

The following comment on the processes revealed at the Conference was prepared by Dr. E. E. Slosson, Director of *Science Service*.

"In the old days before the war, men did not know anything better to do with coal than to burn it. Now they are beginning to find out that it may be put to better purposes as raw material for making more valuable commodities.

"In those days, too, when men wanted to get more gasoline than petroleum contained in crude oil they knew no other way to get it than to smash up the big molecules into little ones; to break down the heavy oils to make light oils. This 'cracking' process was regarded as a great achievement in its day and brought fame and fortune to its inventor; quite rightly, since we could be running few automobiles without it. But the world is passing into another era now, the age of synthesis, when the chemist will build up instead of breaking down. Starting with the commonest and cheapest materials, air, water and coal, the chemist can construct at will all sorts of valuable compounds for which we formerly had to rely upon Nature.

"The veteran French chemist, Prof. Paul Sabatier of Toulouse, opened the door to this new era with the key called 'catalysis.' Shortly before the last century closed, he found that hydrogen gas could be made to unite with carbon-monoxide gas in the presence of finely divided nickel, and produce methane, well known as natural gas. Now these two constituents, hydrogen and carbon monoxide, are easily made by passing steam over red-hot coal—the 'water gas' process. Many other metals and compounds have since been found to act like nickel as a catalyst; that is, they speed up a process by their presence without being used up or appearing among the products.

"This principle has of late been applied with remarkable results by a countryman of Sabatier, General Georges Patart, and still more extensively in Germany by Prof. Franz Fischer, director of the Institute of Coal Research at Muelheim-Ruhr, and Dr. Friedrich Bergius of Heidelberg. All these three European leaders in catalytic research came to Pittsburgh to attend the International Conference on Bituminous Coal, held at the Carnegie Institute of Technology in November, and what they told of the application of catalysis to industry was a surprise to many of our people, for in this field America is far behind Germany and France.

"For instance, we have been making methanol by the old-fashioned method of distilling wood, but now the Badische Chemical Company makes ten to twenty tons of it a day from water gas at a cost of only 20 cents a gallon. Methanol, formerly known as 'wood alcohol,' has long been employed in all countries as a denaturant for industrial alcohol, and has caused many cases of blindness in Germany and America by being used for whisky by those who were already so blind as not to be able to tell one alcohol from another. Various other alcohols, such as butyl alcohol, made in America by fermenting corn and used for automobile lacquers, are made in Germany from water gas. The waste gases that in some sections of the United States are still allowed to escape unused from coke ovens are, at the mines of Bethune, France, cooled and condensed and utilized for making methane, benzene, ethyl alcohol and ammonia.

"Owing to the catalytic process for synthetic ammonia invented by Fritz Haber, Germany is now exporting fertilizer instead of importing it as before the war. About 425,000 tons of free nitrogen from the air is now fixed for fertilizers by catalysis every year, and this takes the place of 2,700,000 tons of Chilean nitrate. But Muscle Shoals still stands idle.

"Benzene, which can be made from coal in various ways, is the mother substance of the aromatic family of chemical compounds, a family of over a hundred thousand and rapidly growing. Among these are the aniline dyes and drugs that have made the world brighter and safer in our generation. One of these synthetic products, carbolic acid is familiarly used as an antiseptic and is nearly as useful but much less familiar as one of the two components of bakelite. The other component of bakelite, formaldehyde, is also an antiseptic and also is made artificially.

"The chief stimulus to such investigations in Europe is the search for home-made motor fuel. We Americans are not interested in this question now but some day we shall be, and meantime it is interesting to watch the chemists over

the water trying to see how many different things they can make out of common coal, like children playing with the Chinese tangram.

"A motorized Europe, in spite of the scarcity of oil wells and the consequent high price of 'gas' on that continent, is thus held out as a possibility as the result of researches on processes for making a practicable motor fuel out of soft coal, which have been going on for nearly a quarter of a century in Germany and France. Prof. Franz Fischer, director of the Institute of Coal Research, Muelheim-Ruhr, Germany, a leader in the search for a practicable synthetic motor fuel, spoke before the meeting of the International Conference on Bituminous Coal, telling of the petroleum-like products he has been able to obtain by subjecting water-gas to pressure and moderate temperature, in the presence of finely divided iron or cobalt.

"Prof. Fisher uses as raw material the same mixture of hydrogen and carbon monoxide familiar in this country as a part of most city gas, under the name of 'water-gas.' This is made by passing steam over glowing coke. The gas mixture thus produced has high fuel-value but cannot be reduced to liquid form except at extremely low temperatures. How to build these small molecules into larger ones, which would be liquid instead of a gas at ordinary temperatures, and still be useful as an engine fuel, was the problem confronting the investigator.

"He solved it by the use of what the chemist calls catalyzers, that is, substances which, in some manner as yet not understood, speed up chemical reactions without themselves entering into the compounds which they call into being. In this case Prof. Fischer used finely divided cobalt and iron; an earlier investigator, he said, had used the allied metal nickel. With these chemical middlemen present, and using moderately high pressures and some heat, he has obtained three different classes of compounds.

"The first of these, 'synthol,' is a mixture of about a score of inflammable compounds, including a number of the higher alcohols, ketones and esters, as well as organic acids and aldehydes. This has considerable value as a fuel. By varying the process, he has been able to obtain a second product, methanol, which is pure synthetic wood alcohol. Other investigators also have obtained methanol; but although it is highly useful in the arts and industries, it has less value as a fuel than the petroleum-like products. A third product, 'gasol,' most recently obtained, is of the nature of an artificial benzine, which again has high fuel value.

"These researches have been carried out on a technical scale, and it has been proved possible to obtain motor fuel from soft coal in commercial quantities, without troublesome by-products for which to find markets. But as yet the process is too costly to compete with imported petroleum fuels. As the latter become scarcer and more expensive, and the technique of fuel synthesis from coal becomes more refined, it is expected that practical manufacture may be undertaken.

"Gasoline, the most valuable of motor fuels, may be made directly from lignite, the cheapest of coals, by a direct and economical process. The inventor of this process for synthetic petroleum, Dr. Bergius, gave details of the manufacture on a commercial scale of light and heavy fuel oils, lubricating oil, benzene and phenol compounds and ammonia from waste coal dust or low-grade coal.

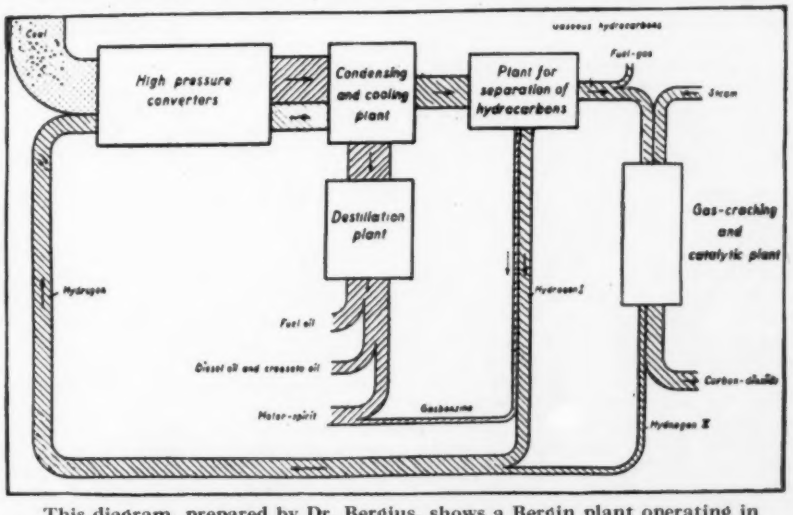
"That the process has passed beyond the experimental stage and is thought likely to become an important factor in the world-wide struggle for new sources of motor fuel is proved by the fact that it has been taken up by strong organizations in Germany, England and in other countries. An international company has been formed to carry on the liquefaction of coal and in this the largest stockholders are the Royal Dutch Shell group, which is the leading petroleum combine of Europe, and the German association of dye manufacturers. The British government is also interested in this method of making artificial oil fuel and a plant for the purpose of investigating the Bergius process has been erected in England. Two experimental plants are maintained in south Germany, employing 150 men.

"The discovery of how to convert coal into liquid products is not a lucky accident but the achievement of long and laborious scientific research, such as gave Germany the supremacy in the manufacture of indigo and other synthetic dyes before the war. Dr. Bergius began his study of the composition of coal in 1912 and, except for the interruption of the war, the investigation has been carried on continuously ever since at a cost of millions of dollars.

"The essential principle of the process consists in combining hydrogen gas with coal by means of high heat and pressure. The coal is first ground into small pieces less than a tenth of an inch in diameter, and then mixed with heavy oil to a thick pasty mass. This is placed in a light steel retort and heated to about 800 degrees, Fahrenheit, under a pressure of about 3000 pounds per square inch. Most of the carbon unites with the hydrogen, giving a complex mixture of gaseous, liquid and solid compounds similar to those coming from natural wells. In the case of lignite, a low-grade brown coal, as much as 90 percent of the carbon is transformed into such marketable products. The nitrogen contained in the coal is transformed into ammonia or liquid bases. A ton of common bituminous coal will yield 300 pounds of gasoline, 400 pounds of heavier oils suitable for Diesel internal-combustion engines, 120 pounds of lubricating oils and 160 pounds of fuel oils. As a rule, about 45 gallons of marketable gasoline can be expected from a ton of soft coal. The second fraction of heavier oils is used in impregnating another batch of powdered coal. Among the products of the process is a quantity of carbolic acid or phenol, a familiar antiseptic and also a component of bakelite, used in radio and phonographs.

"A difficulty of the process, formerly regarded as insuperable, is the high cost of hydrogen. But Bergius gets a sufficient quantity of hydrogen out of the gaseous products of the reaction. Methane, one of these gases, gives four times its volume of hydrogen, when decomposed by steam. The Bergius process can be annexed to an ordinary gas-producing plant, converting the coke into more valuable oils and enabling inferior coal to be used. Dr. Bergius was asked whether his process would pay in the United States but declined to commit himself on the ground of his inexperience with American conditions. He ventured, however, to estimate that the various oil products could be made here at a cost of about ten dollars a ton."

The full report of the Conference, illustrated and bound like any other volume, may be obtained, postpaid, for seven dollars, from the Carnegie Institute of Technology or from the Scientific American.



This diagram, prepared by Dr. Bergius, shows a Bergin plant operating in connection with a plant for the separation of hydro-carbons from the gas

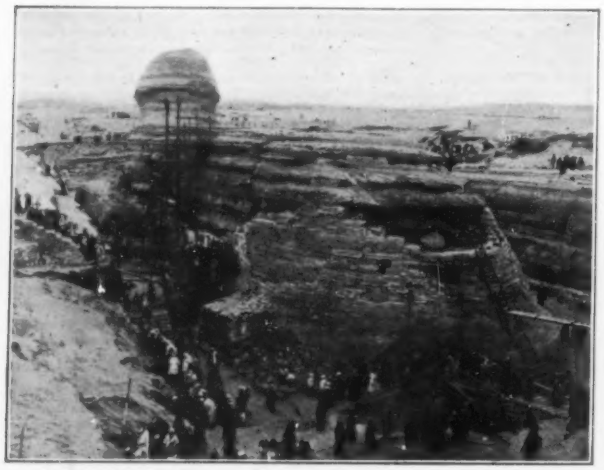
The Sphinx, Recently Renovated, Is Still a Mystery

VISITORS to Cairo can now see the Sphinx, probably the most intriguing and universally known monument in the world, as it appeared when first erected. And the huge dimensions and curious contour of the monument is a revelation to everyone. The fact is, says Harold J. Shepstone, we have not yet learned all the secrets of the Sphinx. For example, no one knows why it was

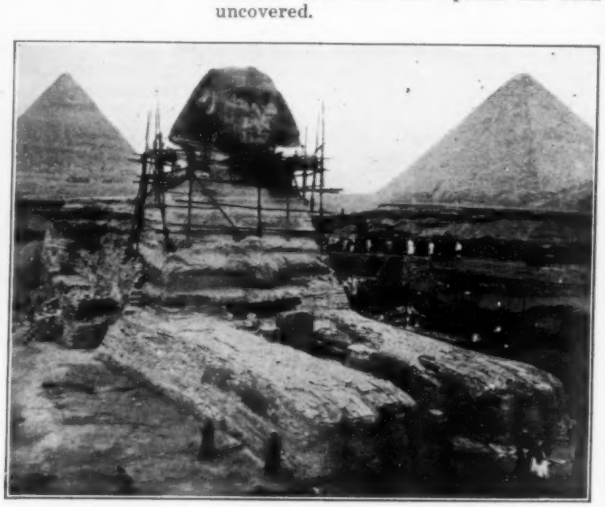
built, or exactly when, or by whose orders.

The decision of the Antiquities Department of the Egyptian Government to remove the sand which partially enveloped the monument and carry out certain repair work on the neck and face was a happy one. All told, the work occupied six months. No doubt such an important archeological undertaking would have attracted much wider attention had it not been overshadowed by other discoveries at Sakkara and the Pyramids, coupled also with the unwrapping of Tutankhamen and the arrival of his marvelous golden coffin at Cairo. The excavation of the Sphinx lacked the popular glamour of gold and precious objects, for so far it has afforded none of these and it is not likely to do so.

In addition to masons and other specialists, an army of 800 girls and boys were requisitioned to clear away the sand. The latter toiled in gangs. Attached to each gang was a hired singer, usually a small boy, who chanted over and over again in a high, fascinating voice some such apparently irrelevant phrase as *"Dis Maloo ala haloo"* ("He spent all his money on himself"), as his fellows passed to and fro with the debris.



Left: A rear view of the Sphinx, showing the contour. The construction is shown here



Right: Removing the scaffolding. Notice the inscribed stone between the huge forepaws

The Sphinx has been much damaged in the past. Mohammed Ali used the monument as a target for his artillery practice. Religious fanatics have tried to destroy its beauty. The legend of chambers of hidden gold in the Sphinx has led to some violent searchings. A hole six feet deep and two feet across had been hewn in the top of the head. There was a similar hole in the left foreleg. These have now been filled up. The monument was also battered by weather, the face crumbling away.

Now that the sand has been cleared away, the magnificent proportions of the monument are apparent. It is partly hewn out of the solid rock and partly built up with stone. In fact, it is the largest piece of sculpture in the world. From the toes on the forelegs to the end of its quarters the monument measures no less than 240 feet in length, and stands some 65 feet in total height. From chin to crown the face measures 33 feet. The mouth is seven and one-half feet across, the nose is five and one-half feet long, and the ear five feet in length.

Between the huge paws there was a shrine, and here was found an inscribed granite slab, or *stela*, set up by Thothmes IV. According to the inscription, Thothmes, when a young man, went lion-hunting in the desert and rested at midday in the shadow of the Sphinx, which even then was half buried in sand. While he slept, he dreamed that the sun god Hermachis, to whom the Sphinx was sacred, appeared to him and told him that he would be a king, and laid an oath on him to dig away "the sand whereon I have my being, which has closed me in on all sides." The young man came to the throne as Thothmes IV, and one of the first things he did was to dig away the sand and restore the sacred monument.

Unfortunately, the last few lines of the inscription on the *stela* are illegible. This is a great pity, as they evidently refer to the building of the Sphinx. One gathers, by skipping a few of the gaps, that the monument was built about 3700 B.C. by Kepheron of the IV Dynasty, who built the smaller of the great pyramids close by. But another tablet found, however, would appear to indicate that the Sphinx was standing long before Kepheron's time, when Cheops, a predecessor of Kepheron, was busy erecting the Great Pyramid. Some archeologists have put the date earlier still. In any case, we know the monument is at least 5700 years old, and probably well over 6000 years.

Thothmes not only cleared away the sand which encumbered the monument, but caused all but its head to be encased in wonderful limestone masonry about one foot thick. This still remains almost perfect on the legs and lower portion of the body, and, as is seen from our illustrations, greatly alters the proportions of the great lion, making the head appear very small by comparison with the forelegs. Thothmes also painted the Sphinx a dark red all over, and much of this ancient color still remains on the head and legs.

Thothmes, in fact, did, in 1700 B.C., much the same in the way of cleaning and repairing the monument as that which has just been carried out by the Egyptian Government. If anything, however, the excavations have rendered this great piece of sculpture more mysterious than ever. We are startled by its enormous proportions. We wonder what is really the meaning of this figure of a crouching lion with a man's head. We know it represents Hermachis, the god of the sun, and that is about all. It is thought by many that a temple stood between its forelegs where the ancient Egyptians came to worship the rising sun, for the monument faces east, standing on a rocky plateau on the very edge of the desert, looking towards the Nile.

Despite the battering which the monument has received from the weather and from the hand of man, it still maintains a super-human dignity. It seems to have a far-off, dreamy, weary look. There is a wonderful sensitiveness about the mouth and the general expression of the monument is enigmatical. And these attributes are all the more pronounced now that the Sphinx has been uncovered.

Geologic Summer School to Tour Canada by Train

A GEOLOGICAL summer school on wheels, housed in a specially constructed sleeping, dining and lecture Pullman car, will roll this year from the Atlantic to the Pacific over Canada's great mineral empire. The trip, extending from July 15 to August 25, will be under the auspices of Princeton University and under the direction of Prof. Richard M. Field.

As foreign guests, two eminent geologists, Prof. Leon W. Collet of the University of Geneva and Dr. E. B. Bailey of the Scottish Geological Survey, will accompany the party of 23, which will include professors and practicing geologists as well as undergraduates and graduate students.

By living and traveling in the special car, a new mine or geological site can be visited nearly every day. The Canadian Geological Survey will cooperate in the instruction. Last year a similar trip was made across the United States and the combination of lectures while enroute and field experiences was proved to be a highly efficient method of instruction.—*Science Service.*

Radio Notes

A Monthly Review of Progress in Wireless Communication

CONDUCTED BY ORRIN E. DUNLAP, JR.

New Tube Uses Alternating Current

A NEW vacuum tube which derives its energy from the house-lighting current is being manufactured in Great Britain by the Marconi Osram Valve Company. The use of this tube is limited to alternating current, being operated through a step-down transformer without a rectifying circuit.

Electronic emission takes place from a cathode, a tiny cylinder coated with radioactive substance, which encloses the filament. When the filament is at white heat, the cylinder surrounding it, being heated by radiation, gives off a high electron flow. This cylinder remains unaffected by any small changes in the temperature of the filament, and therefore the electron flow remains unchanged, according to reports from England.

A grid and plate surround the cylinder in the usual manner of British-made tubes. It takes some time for the tube to start functioning after switching on the heater current, owing to the cylinder requiring to be raised to a certain temperature before the emission begins.

Engineer Predicts Television Receivers

RALPH H. LANGLEY, radio engineer who had charge of set development for the General Electric Company at Schenectady for several years, has been appointed assistant to the president of the Crosley Radio Corporation. Mr. Langley already has assumed his duties and will be the adviser of Powel Crosley, Jr., in technical and scientific matters.

"The near future will bring the development of a combined receiving set and television apparatus," said Mr. Langley, upon taking up his new position. "Both mechanisms will be controlled by the same dial. The loudspeaker will be located behind the screen and a turn of the dial will bring in music and pictures simultaneously."

Langenberg Station

EUROPE'S largest broadcasting station at Langenberg, in the Rhineland, operates on 25 kilowatts and a wavelength of 468.8 meters. Britain is building a new station at Daventry to be known as Daventry Junior, with a power output of 50 kilowatts, on the 400-meter wave.

"Britain does not intend to be shouted down in the ether by Germany," says an English observer.

Canadian Station Uses Special Tubes

STATION CFRB, operating on a wavelength of 291 meters, the latest Canadian broadcaster, is located 25 miles north of Toronto at an altitude of 1050 feet above sea level. The isolated position and high altitude were selected to avoid absorption and reflection of the waves.

Two 100-foot masts support a four-wire flat-top antenna, into which is fed power derived from four 1000-watt water-cooled tubes. Two tubes are used as modulators and two as oscillators, forming the most powerful combination in the Dominion.

The tubes have been developed by E. S. Rogers of Toronto, and operate directly from the alternating-current house mains. The tubes are of the thimble-shaped cathode type, with raw alternating current fed to the heating elements. The plate and grid voltages are supplied from a rectifier, also operating from the alternating-current lines. Two stages of amplification with two low-impedance tubes in each stage are used in the voice amplifiers.

The programs are sent to the station over telephone lines from one of the art galleries in Toronto, where accommodations are provided for the artists.

Underwood and Underwood

The transmitter of station WVT operates on wavelengths of 600 to 3600 meters. The two large coils in the background are known as harmonic eliminators, which prevent interference with the broadcast programs

United States Leads

THE United States, with 733 stations, leads the world in the development of broadcasting, according to an international survey compiled by the Department of Commerce. There are 340 broadcast transmitters outside of this country, with the foreign stations divided as follows: Europe, 164; North America (excepting United States), 85; South America, 38; Asia, 16; Oceania, 28, Africa, 9.

Just as there is a boom in radio-station building in this country, the same thing seems to be the case elsewhere, as is shown by the fact that many foreign stations have been projected within the last six months.

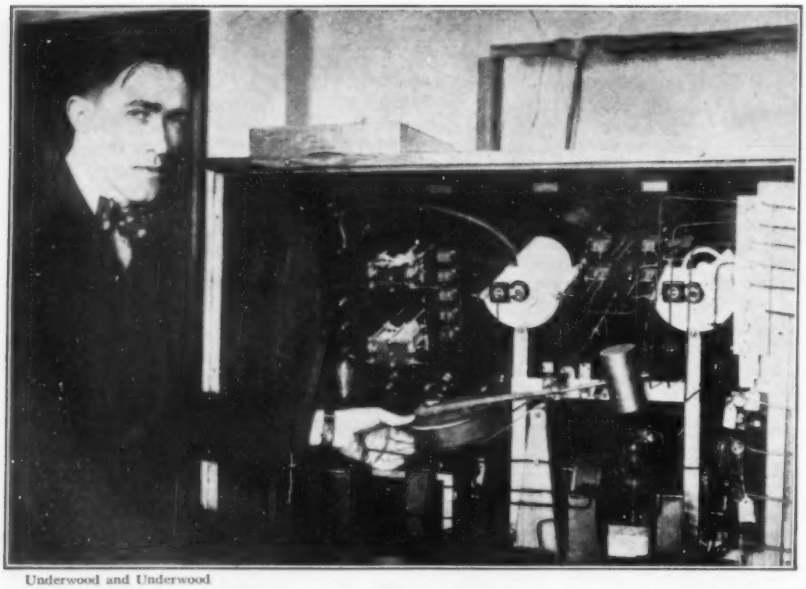
Stations WGY and WJZ are the most powerful broadcasters in the world. Both are rated with an output of 50 kilowatts, although it is reported that WJZ seldom uses more than 34 kilowatts. Daventry, England, using the call 5XX, is next, with a rating of 16 kilowatts.

Always there persists the rumor that there are several mysterious Bolshevik Russian stations of tremendous power for the purpose of broadcasting propaganda, but the largest station in that country noted in the official list is ROW, at Moscow, rated at 8000 watts.

As a rule, the well-known foreign stations do not average nearly as high power as the transmitters on this side of the sea. For instance, FL, the Eiffel Tower in Paris, is using only 4000 watts, and MRD, at Toulouse, 1000 watts. The most powerful station in Austria is at Vienna, rated at 7000 watts, and BAV, the outstanding station of Belgium, in Brussels, uses only 1500 watts.

Hamburg and Munich lead the stations of Germany with 4000 watts, while the largest in Italy, IRO, at Rome, employs 3000 watts. On the other hand, a much smaller country, Lithuania, boasts of Station RKY, at Kovno, with 10,000 watts. SASF, at Karlsborg, Sweden, is 5000 watts and the most pretentious station in Switzerland, the Radio-Berne, 1500 watts.

Station 2LO in London, than which there is no more famous in Europe, is but 3000 watts. On the other hand, the



Underwood and Underwood

This equipment, designed by the Bureau of Standards, is for standardizing wavelengths. The harmonic amplifier in this set establishes a standard from which transmitting stations are adjusted accurately

Canadian station CKCW, at Burketon Junction, uses 5000 watts, and 2FC at Sydney, Australia, 2000 watts. Both Canada and Australia have almost as many 1000-watt stations as their mother country.

PWX, at Havana, and CZE, Mexico City, so frequently picked up in this country, use only 500 watts. HHK, the United States Marine Corps station at Port au Prince, Haiti, also heard in this country, is 1000 watts. Argentine boasts of no less than six 1000-watt and two 500-watt stations in Buenos Aires alone. Brazil has only a single 1000-watt station in the entire country, SQIG, in Sao Paulo, as is the case with Chile, which has a station utilizing 1200 watts at Santiago.

In all China but a single station is listed, which is operated by an American firm and has a power of about 100 watts. The largest station at present noted in Japan is only 300 watts, but Cape Town and Durban, South Africa, each have 1200-watt stations.

Engineer Compares Batteries and Eliminators

THERE has been considerable controversy of late regarding the reliability of "B" socket-power units as compared to the high-quality, heavy-duty dry-cell "B" batteries. When the first "B" socket-power outfits were proposed, it was to replace a rather inefficient type of dry-cell "B" battery, and it is a matter of recent history that many of the first socket-power units failed in providing desired relief as regards reliability and reduced cost of operation, according to Ray P. Manson, Chief Engineer of the Stromberg-Carlson Manufacturing Company.

"It must not be overlooked that with the improvements in 'B' eliminators, the dry-cell 'B' battery also has been greatly improved," said Mr. Manson. "So today, the comparison must be made between the best heavy-duty dry-cell 'B' batteries and the best designs of 'B' socket-power units.

"When considered from the best designs in each class of current supply, there are only two factors that enter into the question. First, there is the matter of uniform voltage throughout the life of the 'B' socket-power and its rectifying element, as compared to the voltage of the dry-cell 'B' battery throughout its active life. Second is the cost of operation of the 'B' socket-power unit based on the first cost spread over a period of four or five years, plus renewals of the rectifying element, as compared to the replacement costs of dry-cell 'B' batteries.

"The first question is one of uniformity of operation of the receiver, and if this is the deciding question and the 'B' socket-power unit is correctly designed to give a uniform voltage output through long periods of time, then this type of 'B' current supply naturally would be given preference over the dry cell which unfortunately has a drooping characteristic, the voltage gradually decreasing as the dry cells become worn out.

"From the standpoint of operating costs it will be found that on receivers employing a total of five tubes, the output tube being of the power type, that the largest heavy-duty dry-cell 'B' batteries will just prove-in from the cost standpoint. Thus, in locations where there are no suitable alternating-current lighting circuits from which to operate the 'B' socket-power units, dry-cell 'B' batteries can be used satisfactorily on receiving sets up to six or seven tubes, including a power output tube. When figured on a three to five-year basis, the highest priced 'B' socket-power outfits will prove-in from the first cost and operating cost standpoints, and have the additional advantage that the operating voltages will be uniform, thereby maintaining the receiving set at its highest operating efficiency at all times.

"This applies to the latest heavy-duty dry-cell 'B' batteries and the best designs of 'B' socket-power units. There is another qualification in regard to the 'B' socket-power unit that must not be overlooked—that is, the keeping of the output voltages down to a reasonable level, say 135 volts for the UX-171 power tube. If this output voltage is allowed to run 180 or over, then it may be found that the rectifying tube or element, as well as the power tube of the receiver, may have comparatively short life, say about one half that obtained when the lower 'B' voltage is employed.

"This brings out the fact that it is preferable to have a 'B' socket-power unit designed to give a uniform voltage throughout a long period of time, than one which starts with a very high voltage and through overload of the rectifying element, as well as overvoltage of the amplifying tube in the receiver, to have a comparatively short life with the same type of sloping characteristic to the voltage output, as provided when the dry-cell type of 'B' batteries are used."

Radio Business Best in October

OCTOBER is the most productive month in radio sales and June is the lowest, according to a chart compiled by the National Electrical Manufacturers. The sale of accessories such as batteries, loudspeakers and current-supply devices reaches a peak in November and then begins to drop off until the low point is reached in June.

The chart reveals that sales diminish rapidly in March, maintaining the decline until the latter part of June, when the upward sweep begins.

It is pointed out that better radio business is expected this summer because of the new regulations, which will minimize interference and restore law and order in the ether.

Herbert Photos

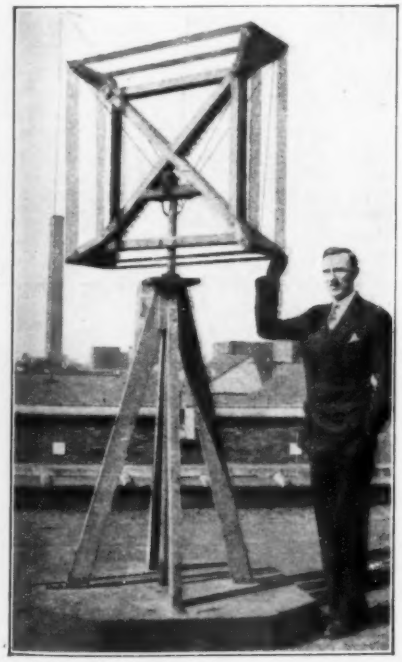
This short-wave receiver, built by T. A. Smith, of New York, uses two separate grounds and no antenna. The circuit has received Australia on 10 meters. It uses one stage of radio-frequency amplification

Latest Radio Studio

THE radio studio in the Roxy Theater, New York, represents, as far as acoustical properties, construction and operating convenience are concerned, the latest advance in every art which has entered into its making.

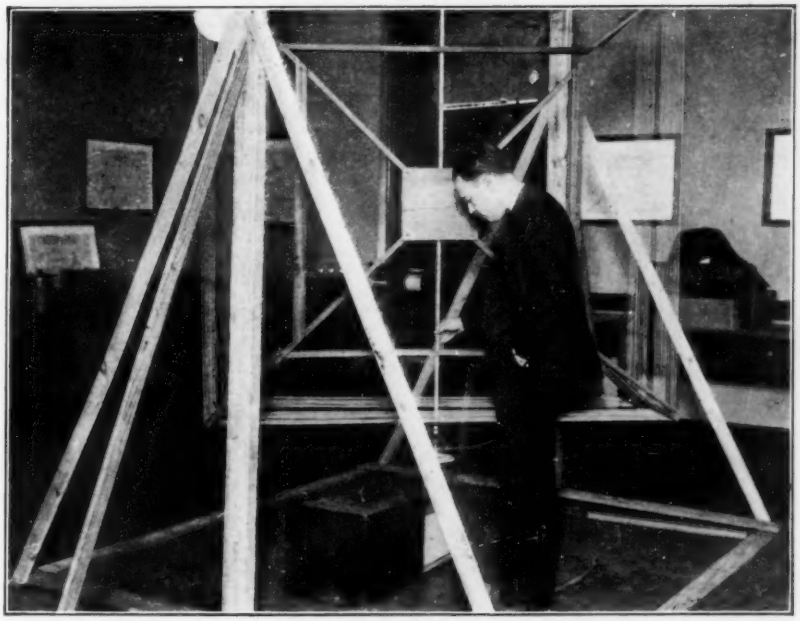
The studio is located on the fifth floor of the building, far enough above the street level to insure that traffic noises will not affect the sensitive microphones. The walls, floor and ceiling have received special treatment which makes them contribute their share to the fine tonal values of the studio, which is one of the few that has been planned and constructed especially for broadcasting purposes. The exact plans and specifications of the studio, control room, generator room and visitors' gallery were laid out in detail by broadcasting engineers working in conjunction with architects familiar with this phase of construction.

A cross-section view of the broadcasting rooms reveals that the studio proper is twice the height of the control room and the visitors' gallery. The studio is constructed without pillars or breaks in the wall surfaces which might destroy its acoustical properties. Every corner of the room, including those between the side walls and the ceiling, is a 90-degree angle. Through the middle of the ceiling, a square shaft runs to the organ loft, which contains a specially designed organ used only for broadcasting. Above the surface of the studio ceiling, in the loft, the four walls of this shaft consist of shutters, any of which may be opened to any degree, controlling the volume of the organ music which can enter the studio and the microphone, as well as allowing emphasis to be placed upon any desired portion of the music.



Underwood and Underwood

This loop antenna at WVT, Army Net Control Station of the Sixth Corps area at Chicago, has a wavelength range of 1000 to 3000 meters



Harris and Ewing

This automatic loop antenna, designed at the Bureau of Standards, turns at a certain number of revolutions per hour, day and night. Thus static and other phenomena may be studied without an operator's aid

The organ is operated from a manual in the studio directly beneath the loft. At regular intervals around the walls of the studio are microphone outlets connected with the control board. Since many different kinds of music are to be broadcast from the studio, including the work of a large chorus, many more microphone outlets have been provided than in most remote-control studios.

Machine Tests 30,000 Tubes a Day

AN automatic device which tests 30,000 radio tubes a day, whereas the most skilled human operator cannot test more than 2000 tubes in a ten-hour day, has been installed in the factory of the Westinghouse Lamp Company at Bloomfield, New Jersey. Furthermore, the human operator is bound to make occasional errors in the work, but the machine seldom makes a mistake. For the period of several months during which the machine has been in service, its record for accuracy stands at 99.9 percent. However, the 0.1 percent error is not chargeable to the machine, but, according to the engineers, to the accidental introduction of defective tubes into the good stock.

The tester consists of a revolving disk, about three feet in diameter, which carries sockets for tubes on one of its faces. As the disk revolves, the tubes are connected successively to terminals which connect them with instruments that indicate various characteristics. If a tube is found wanting, it is pushed out of its socket by an electro-magnetic plunger located in the rear of the machine.

Tubes that are hopelessly bad are unceremoniously shot into a "down-and-out" and sent to the scrap heap; but those that can be reclaimed are laid on moving belts which convey them to operators for further treatment. Perfect tubes are also placed on a belt and are carried to the wrapping department.

The points for which tubes are tested are: short circuits, broken filaments, electronic emission, gassiness, and high and low plate current. Some of these tests involve the use of extremely small currents, and special sensitive relays are employed to operate the ejecting mechanism. Each test is a positive one, and each testing mechanism operates to eject tubes in case they should be damaged during the process of testing. Hence, when the machine O. K.'s a tube, that tube is a good one.

The machine is arranged to be fed by two girls seated side by side. After it was placed in operation, the fact developed that one of the girls should be left-handed and one right-handed. A search soon disclosed a left-handed operator who, for once at least, found advantage in her peculiarity. But, alas! She is destined to lose her job soon, because the machine is being arranged to be fed automatically in order to bring it up to its full productive capacity of completely tested tubes.

Varying Wavelength

THE use of copper tubing in short-wave transmitting aerials makes it fairly simple for the broadcast station operator to vary the wavelength in an emergency. At KDKA, Pittsburgh, the wavelength may be varied by inserting a copper rod in the tubing of the horizontal counterpoise. The variation depends on the distance the rod is pushed in.

Rules For Antennas

A NEW handbook has been issued by the Bureau of Standards as a part of the national code which contains safety rules governing radio installations.

This book is known as "Number 9" and may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is ten cents.

Learning To Use Our Wings

This Department Will Keep Our Readers Informed of the Latest Facts About Airplanes and Airships

CONDUCTED BY ALEXANDER KLEMIN
In charge, Daniel Guggenheim School of Aeronautics, New York University

Bellanca's Transatlantic Preparations

IN the opinion of Grover C. Loening, one of the best informed aeronautical engineers in the United States, the attempts to make a non-stop flight from New York to Paris are injuring rather than helping the cause of aviation. The non-stop flights are in the nature of "stunts." The planes are overloaded with fuel to such an extent that they become dangerous, as two fatal accidents have already shown at the time of writing. Such accidents have no bearing on ordinary commercial flying with normal wing loadings. But it is hard for the public to differentiate.

Whether the Bellanca plane will actually succeed in the flight, or whether the French pilots, Nungesser and Coli, making their attempt at the time these lines are being written will be first to achieve the crossing, is uncertain. But it is gratifying to see the care and skill with which Bellanca and his associates are making their preparations.

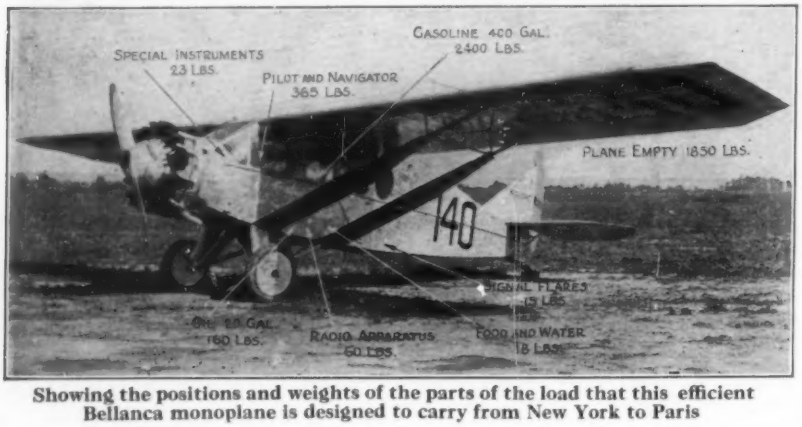
The Bellanca monoplane is not an experimental ship. It has been in process of design, experimental construction and test ever since 1921, and is now one of the finest examples of aeronautical construction.

The untapered monoplane wing, 46½ feet in span and six feet, seven inches in chord has a profile combining fairly high maximum lift with efficiency at cruising and maximum speeds.

The supporting structure of the wing, while amply strong, is reduced to a minimum. The struts, which must be there of necessity, are themselves of lifting airfoil section. Because of this, the struts, while offering no more resistance than the conventional struts, lift at least their own weight, and probably more.

The fuselage is the greatest single item in the parasitic resistance of a plane. Aerodynamically, the fuselage is extremely sensitive to any openings or projections. For example, an improper application of windshield in an open cockpit may increase its resistance by 50 percent. In the Bellanca, in which both pilots and passengers are entirely enclosed, there is no body opening or projection to disturb the air flow.

The air-cooled engine now offers superiority in lightness and reliability over the water-cooled power plant. The sole remaining objection is in the high resistance of the projecting cylinders, and of the exhaust piping. In the Bellanca, the best modern practice has been followed in cutting down such resistance. The cowling forms a smooth line blending beautifully into the propeller spinner. The two magnetos are covered in by gentle "bosses," over which the air flows with minimum disturbance. The cowling leaves only so much of the cylinders and heads exposed as is absolutely necessary for cooling. The exhaust ring, to which each of the nine cylinders of the Wright-J engine connects, is exposed to the air blast—as is proper since the ring must not be allowed to become too hot—but it is flattened into a streamline section, as are also the exhaust stacks or stubs themselves from which the gases finally emerge.



Showing the positions and weights of the parts of the load that this efficient Bellanca monoplane is designed to carry from New York to Paris

Compared with some of the large three-engined planes, the Bellanca plane looks a little frail. But it is quite sound structurally, and good design has allowed the weight empty to be kept low.

As an ordinary commercial passenger-carrying craft, its weight distribution is as follows: Weight empty, 1850 pounds; 64 gallons of fuel, 5 gallons of oil and pilot, 579 pounds; pay load of 5 passengers and baggage, 1025 pounds. Total weight, 3454 pounds. With the wing area of 272 square feet, this gives a loading of 12.7 pounds per square foot, which is high though not excessive, and a loading per horsepower of 17.2 pounds.

The performance as given by the manufacturer gives a high speed of 130 miles per hour, and a cruising speed of 110 miles per hour when using only 125 horsepower and 11 gallons of fuel per hour.

Wide World

Acosta, left, and Chamberlain, who piloted the Bellanca plane in a record endurance flight of 51 hours, 11 minutes. Because of his greater weight, Acosta yielded to Chamberlain as pilot for the transatlantic flight

What is so admirable in the proposed expedition, is the careful way in which everything mechanical is being put into first class order; the exhaustive flight tests to check up fuel consumptions at various revolutions of the engine and speeds of the plane; the marvelous endurance flight of 51 hours, 11 minutes—the best possible test of the ability of plane and pilots to maintain an unbroken voyage of nearly two days duration across the ocean; and above all the care in watching weights. It was perhaps generosity in allowing weights to pile up which wrecked the hopes of both Sikorsky and Commander Davis.

Clarence D. Chamberlain and Bert Acosta, while companions in the splendid endurance flight, had become fast friends. When it came to selecting the pilot for the transatlantic trip, Acosta gracefully relinquished his claim to the position because his sturdier build meant 60 pounds more weight than that of the slim Chamberlain. The lightest gasoline tanks are used; the equipment selected is adequate but not of excessive weight; the fuel carried is enough to give a reasonable margin but no more; no presents for Paris and no luxuries are carried. The weights now stand as follows: plane empty, 1850 pounds; gasoline, 400 gallons, 2400 pounds; oil, 20 gallons, 160 pounds; radio apparatus, 60 pounds; food and water, 13 pounds; signal flares, 15 pounds; earth inductor compass, 15 pounds; octant, eight pounds; drift indicator, two pounds; special chronometer, one half pound; stop watch, one half pound; total 4891 pounds.

Of course the plane will be overloaded as compared with its ordinary commercial condition. But the overloading will not be excessive, giving only 18 pounds per square foot of wing area and 23.3 pounds per horsepower. The areodynamically efficient plane will have no difficulty in getting up sufficient speed to make a get-away. The first hours in the air will give cause for anxiety, but the hazards are at least reasonable.

At the start of the flight with full load, if cruising at 110 miles per hour, the fuel consumption would be heavier than the 11 gallons an hour quoted above. But the pilot may reduce consumption of fuel per mile by flying more slowly. As the plane lightens, the fuel consumption will go down. The figure of 11 gallons per hour at an average of 110 miles per hour may therefore be achieved. This, for a flight of 3600 miles, will mean 368 gallons of fuel, leaving a margin of 32 gallons. At the last minute, an extra 30 gallons may be stowed in the cabin in five-gallon tins. There is a fair sporting chance of getting across, or at the worst of landing on the west-coast of France without actually reaching Paris.

Wide World

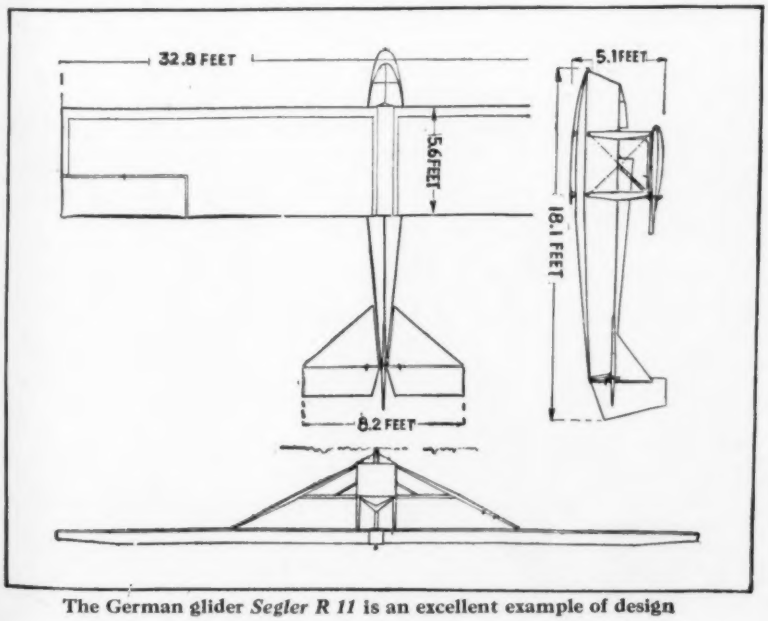
The famous glider pilot, Espenlaub, superintending the attachment of his glider to an airplane, just prior to experiments to test the practicability of discharging freight from moving planes by means of gliders

A Neat Glider

GLIDING as a sport has never taken a serious foothold in the United States. In Germany it is being pursued as intensively as ever, and various societies exist which provide their members with systematic training and subsequent practice. One such society is the Rhön-Rossiten Gesellschaft which holds its exercises *auf der Wasserkuppe* in the Rhine valley, at a spot where meteorological conditions are particularly favorable.

It is surprising how quickly students qualify as glider pilots. During the month of September, 1926, the society gave 18 elementary and 11 advanced gliding certificates. Instruction was given on 22 days of the month. There were 450 glides made, of an average duration of 30 seconds, or a total of only three and three-quarter hours of gliding time. Some of the advanced students finally managed duration glides of some seven and one half minutes. We have never heard of anything as systematic and earnest in the gliding line in the United States.

The gliders used by this society are beautiful examples of aerodynamical and structural design. Our diagram shows the *Segler R 11* (glider) on which advanced students receive instruction. It has beautiful lines and the most correct and efficient disposition of surfaces. Anyone building a glider could not go far wrong in working on similar lines.



The German glider *Segler R 11* is an excellent example of design

Towing Gliders

THE Army Air Corps has for many years been experimenting with target gliders towed behind an airplane, to be released for practice shots from anti-aircraft guns. It has remained for a German firm, the Raab-Katzenstein Airplane Company, to experiment with such gliders for commercial purposes. The airplane has a cable about a thousand feet in length attached to its fuselage, and this cable is attached to the front end of the glider, with a release which the glider pilot can readily actuate. The idea is to have the airplane act like a locomotive with a line of freight cars, and detach the freight-loaded gliders one by one as they reach their destination.

Experiments conducted by the German ace, Kieseler, in the plane, and Espenlaub, the famous glider constructor, in the towed glider, have been entirely successful, as far as safe release and landing were concerned.

From the point of view of airplane economics, however, the idea does not seem promising. For the same freight

(*Continued on page* 89)

In the World of Chemistry

A Department Devoted to the Advancements Made in Industrial and Experimental Chemistry

CONDUCTED BY D. H. KILLEFFER

A New Slant on the Smoke Nuisance

CONTROL of the smoke nuisance must depend upon the effect of smoke-laden air on health, if success is to be achieved, according to Dr. Charles White, pathologist of the United States Health Service, who points out in *American City*, that smoke prevention will be more readily secured if it can be shown that smoke-laden atmosphere has a harmful effect on the human system. The chief arguments heretofore have been for comfort and cleanliness. Data collected by him show that the city of Pittsburgh has a low tuberculosis death rate but a high pneumonia death rate, an analysis by wards showing that the higher rates occur where the smoke-laden air is denser. The number of physicians specializing in respiratory diseases is higher per capita in Pittsburgh than in Baltimore, showing a greater demand for this type in the smoke areas. The evidence indicates that smoke must be controlled from the viewpoint of its effects upon public health.

Artificial Ripening of Fruits and Vegetables

THE storing of fruits and vegetables in an unripe condition and then ripening them as required by the conditions of the market, is forecast by Dr. R. B. Harvey, Associate Professor of Plant Physiology and Botany at the Minnesota College of Agriculture, as a result of an extensive research on the action of ethylene and propylene on fruits and vegetables. In the past, ethylene has been used for coloring citrus fruits and by its use it has been possible to make green fruit appear ripe, which was none too proper. However, Dr. Harvey has found that by continued application of either ethylene or propylene, an actually green fruit can be made to undergo exactly the same changes in composition that occur in ripening on the plant. In discussing his results in an article published in the *Chemical Bulletin* (Chicago), Dr. Harvey says in part:

"At the Minnesota Experimental Station we have now ripened practically all of the important fruits and vegetables of tropical and temperate climates, so that ethylene seems to have widespread application. It is useful in removing excess acidity from early apples, plums, rhubarb, pineapples, and other fruits. It will produce better flavor in musk, honey-dew, and casaba melons. Of the tropical fruits, we may now hope to have a greater share available in the north. The mango, avocado, papaya, custard apple, chayote, jujube, and persimmon offer commercial possibilities since they may now be shipped in a firm green condition. In Minnesota, during most of the year, quantities of fresh tomatoes are imported, sometimes with the loss of half of the car by the old method of heat treatment. Possibly we should look to the advantage of future generations of northern races in having fruits from the tropics available throughout the year as much as to the money saving through decreasing the loss of human food materials.

"Ethylene is the most practical gas for use in ripening, although propylene is a little more active and produces a little better flavor in fruits. Propylene is not available commercially at present. Acetylene is considerably more toxic than ethylene or propylene and has an unpleasant odor in the comercially available product. Ethylene can be obtained in cylinders.

"A measuring gage can be made by attaching a calibrated orifice to an ordinary low-pressure expansion valve, although there is a convenient valve already on the market calibrated to deliver a regulated amount of ethylene gas per minute. Other than this simple equipment, all that is necessary is to have a banana room or similar room tight enough to prevent excessive leakage of gas. This room must be kept at 65 to 70 degrees, Fahrenheit. At temperatures below 65 degrees, Fahrenheit, ripening is slow. Temperatures above 70 degrees, Fahrenheit, may be used for some fruits, but rots may develop too rapidly. At 65 degrees, Fahrenheit, only 48 hours are required to ripen bananas from a very green state.

"Ethylene is not explosive at concentrations many times the required concentration (1-1000). It is practically odorless and not poisonous. No effect on men working in the treating rooms is detectable. The gas has almost exactly the density of air and diffuses quickly throughout crates of celery or through loose boxes of fruit.

"Ethylene may be used to remove the excess acidity of fruits or vegetables, to remove chlorophyll from celery or similar plants, to increase the sugar content, or to remove tannins and other objectionable substances. Tomatoes ripened after removal from the vine in winter are liable to be excessively acid, but if treated with ethylene they have a fine flavor, free from excess acidity. Very immature tomatoes down to one inch in diameter may be ripened in six to eight days; more mature fruits require only 24 to 60 hours, depending upon the variety and degree of maturity. It is practicable to ripen two-thirds or three-fourths size tomatoes for the market at times of high prices. Tomatoes have better flavor when so ripened than those ripened on the vine. This will make it possible to extend the length of the season by ripening immature fruits before the regular season, and also will save fruits caught green by frost.

"Celery can be blanched perfectly in 60 hours and has a fine color, sweeter taste, and less stringiness. A single dose of ethylene, about two to three cubic feet, costing less than 40 cents per carload of fruit, is sufficient to produce a remarkable change in the time required to ripen bananas, and to change their color, flavor, and texture to that of fine, ripe fruit. The tannins of the date and of the Japanese persimmon have been more quickly removed than is possible without ethylene. The astringent Japanese persimmons were nicely ripened in 50 hours with ethylene, while controls at the same temperature were still very astringent. Ethylene causes a sudden jump in the respiratory rate after its application. Attendant with this increased rate of respiration, the fruit acids and tannins disappear."

This process has been in practical use for some time with extremely satisfactory results.

Carbon Monoxide in Automobile Service Stations

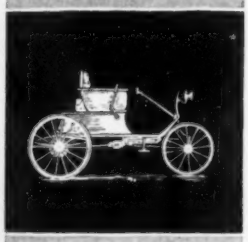
SINCE the exhaust of an automobile engine contains nearly 6½ percent of carbon monoxide, employees of service stations are subject to a severe hazard from carbon monoxide poisoning. Dr. May R. Mayers, of the Bureau of Industrial Hygiene of the New York State Department of Labor, is carrying on an investigation of methods of combating this hazard and in the *Industrial Hygiene Bulletin* of the Bureau says:

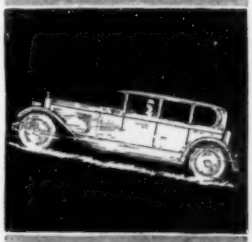
"Various methods are being experimented with by the automobile industry at the present time with a view to ridding their service stations of the carbon-monoxide hazard. The installation of elaborate forced-draft ventilating systems, capable of keeping the air fresh at all times appears to be far too expensive to be practicable in most instances. Instead therefore, managers of service stations are becoming interested in the use of various chemical substances now on sale, which if sprayed, or otherwise introduced into the air are supposed to 'improve the condition of the air.' Just how this is to be accomplished is frequently very vague both in the minds of the manufacturers of these products and those who purchase them for their service stations.

"The Bureau of Industrial Hygiene has been called upon by some of the more intelligent service-station managers —particularly those having a large number of service stations to provide for— for a disinterested opinion as to the efficacy of these measures. One of the chemical substances on the market is essentially a combination of chlorine and formaldehyde which is to be sprayed into the workroom. This is now under investigation by the Bureau. The other chemical substance which is making con-

(*Continued on page* 76)

Automobiles have improved *but— what about gasoline?*





IT IS a far cry from the "horseless buggy" of yesterday to the automobile of today. But the first cars and the latest cars are alike in one fundamental respect: *both depend on gasoline for fuel.*

Gasoline is not a perfect fuel. It has always had one inherent fault. It explodes too quickly ("knocks") as temperature and compression increase.

Carbon increases both temperature and compression beyond the point at which the present day automobile is designed to operate efficiently on regular gasoline. And the full efficiency of the modern motor car and its continued development have both depended upon the discovery of a *"knockless" fuel.*

After eight years of experiment, General Motors Research Laboratories developed Ethyl brand of anti-knock compound, a chemical ingredient which leading oil companies are mixing with their regular gasoline to form *Ethyl Gasoline.*

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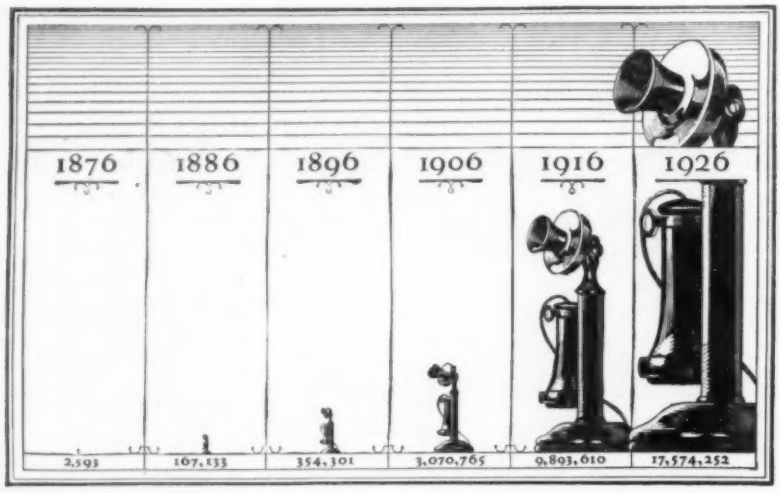

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The year 1926 brought the service of the Bell Telephone System measurably nearer that goal. Seven hundred and eighty-one thousand telephones were added to the System—bringing the total number interconnected in and with the Bell to more than seventeen and a half million.

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The largest number of miles of toll wire for one year was added to the System—more than 664,000 miles.

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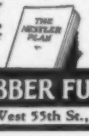

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(*Continued from page* 74)

siderable headway in garages and service stations is ozone, chemically designated as O_3. Ozone is generated in the room by means of one or more ozone generators of varying sizes depending upon the size of the service station.

"Manufacturers of these ozone machines are not all agreed as to its effect either upon the air of the workroom or upon the men exposed. One manufacturer in his sales literature points out that ozone or O_3 is broken down into O_2 plus O, and that the one atom of nascent oxygen combines with the carbon monoxide in the air to form carbon dioxide which in the concentration produced would be quite harmless, ($O + CO \rightarrow CO_2$). In this contention he is not supported either by the other manufacturers of these machines or by experimental evidence. That under conditions prevalent in service stations, this reaction does not occur to any appreciable extent whatever is well established scientifically. This conclusion has further been independently arrived at and confirmed by experimental work conducted by the Bureau of Industrial Hygiene.

"The fact that many of the men working in service stations where these machines have been installed 'on approval' appear to be genuinely enthusiastic about them, however, and claim that they feel so much better and have fewer or no headaches since their installation, has caused the Bureau of Industrial Hygiene to investigate the matter further. It has been our experience as a result of an examination of a considerable number of these men that exposure to carbon monoxide seems to make them hyper-suggestible. The question immediately arose, therefore, whether perhaps the sole effect of these machines was psychological. On the other hand, the men continue to insist that they really do have fewer headaches, and some claim to have none at all any more since the ozone machines have been installed. The carbon-monoxide headache is too real and too intense to be disposed of purely by suggestion."

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CHARCOAL and a number of other things have the desirable property of being able to absorb huge volumes of many gaseous and liquid materials, as witness the use of a piece of charcoal in the family ice box to absorb food odors. This property of absorption, or adsorption as it is more correctly called, is valuable in many industries, and much effort has been devoted to increasing the adsorptive capacity of charcoals. This has resulted in the development of a whole host of "activiated carbons" possessing very high power of adsorption, and in addition to the activated carbons, several types of highly adsorptive silica have been developed which can be used for a number of things for which charcoal is unsuited. The most recent of these has been developed in the Bureau of Soils at Washington as one of the products obtained along with potash and other materials from greensand, and is called glauconite. The new industry of obtaining potash from

(*Continued on page* 84)

Sweet (?) girl graduate

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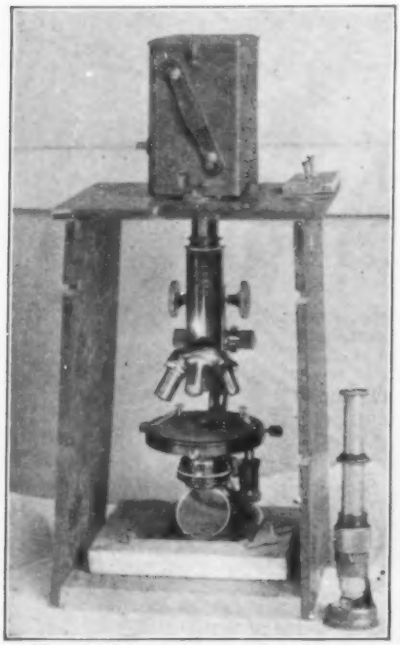
Photomicrography Made Simple

THE writer is one of the undoubtedly large number of amateur scientists who delight in exploring the realms of minute objects that are revealed to us through the medium of the microscope.



Here is shown the complete layout for photomicrography. A high-power microscope is in the stand; a low-power one is at the right

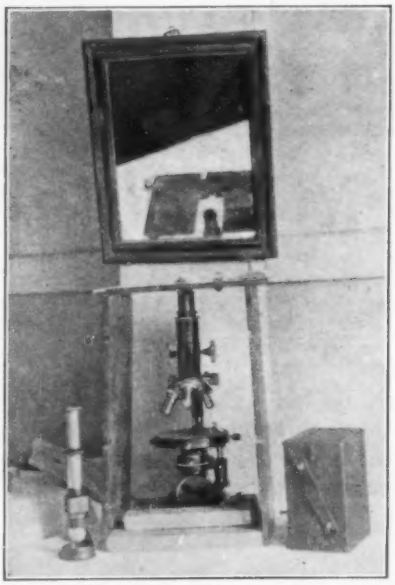
In studying objects and their structure through a microscope, I have often desired a method whereby I could obtain a permanent record of the observations. Not being a master of the technique of drawing, the field of photography seemed to offer the only logical solution. However, the available literature on the subject of photomicrography stated that elaborate equipment was necessary for the taking of photomicrographs. I found that I could not afford such apparatus, so I set to work to prepare a system whereby, with comparatively cheap equipment, coupled with a good microscope, I could produce satisfactory results.

After some little experimenting, I found that with the simple apparatus shown in the accompanying photographs, I could take very good photomicrographs. Several samples of the work done with my equipment are shown also.

Aside from the microscope, the essential parts of the apparatus are three in number. First, there must be a cheap box camera, of a type in which the back is removable. Such a camera need not cost more than two dollars. Secondly, a stand for the camera and the microscope is to be made. This is shown in the photographs.

The third part is a source of light. I used a 100-watt lamp and a thin-walled, globular glass bulb filled with distilled water. The latter is used as a condensing lens for converging the beams from the electric lamp to the microscope mirror. This bulb of water is to be arranged so that it can be moved vertically, so as to make it possible to direct the beams as desired. A fine ground-glass plate is placed between the source of light and the glass bulb. Also, a properly ventilated metal housing should be provided for the electric lamp.

The stand for the microscope and the camera is worthy of special notice. It must be constructed rigidly so that there will be no chance of vibration of the camera during exposure. Due to the variations in the sizes of microscopes, no definite dimensions are given. However, the base, sides and top should be



The microscope and camera stand with the camera removed. A mirror is arranged to show the reader the construction of the top and the placement of the bolts

cut from one-inch stock, and securely fastened together with screws, not nails. A properly shaped block screwed to the base serves at all times to hold the microscope in the same position relative to the top. This is clearly shown in the photographs.

The square nuts on two bolts through the top serve to help the operator to place the camera in the proper position after it has been removed for the purpose of focusing the microscope or inserting the film. As shown in the mirror in one of the photographs, these are set in slots, so that when loosened, the bolts can be shifted to accomodate the particular camera used.

Before attempting to take photomicrographs, the lens in the camera is

A grain of potato starch, magnified 675 times and photographed

removed, as it is of no use in this work. Then the camera, with the back removed, and without any film in it, is placed over the opening in the top board. The microscope is placed in its position on the base, and a piece of ground glass is laid on the back of the camera. The stand should be of such height that the eyepiece of the microscope will be fairly close to the opening of the camera. The farther away it is, the smaller will be the resulting picture.

When the light and mirror of the microscope are adjusted, a circle of light will be seen on the ground glass. The position of the camera should be shifted until this circle occupies the center of the glass. Then the nuts are tightened so that camera will always be replaced in the same location. These nuts do not

(*Continued on page* 80)

The eyepieces used. The top of each is placed to the right of it. Micrometer focusing eyepiece is shown at the extreme right

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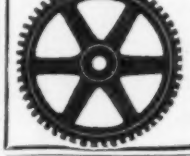

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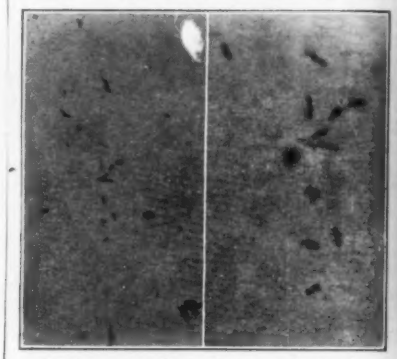
clamp the camera but serve as guides.

In the actual taking of the photomicrographs, the microscope is focused with the eye in the usual way, with the camera removed. Then the camera, with first film in position, is placed against the two square nuts. With the room in darkness and the microscope light turned off, the shutter is opened. Then the light is turned on, the exposure made, the light turned off, and the shutter closed. Be sure to follow this sequence, because opening the shutter while the light is on will tend to shake the camera and spoil the photograph. Do not move around the room while the shutter is open, and be sure that there



Both parts show vinegar bacteria. Left: magnified 675 diameters. Right: 1800 diameters

will be no other disturbing vibration while the exposure is being made.

The exposure for this work will vary from 10 to 30 seconds, according to the subject on the slide, the strength of the light and the power of the lens combination being used.

The foregoing paragraphs deal with ordinary photomicrography. However, I have recently developed a method of very sharp focusing, by means of which it is possible to photograph bacteria, using a high-powered microscope. For this work it is necessary to have an instrument which is made so that different eyepieces can be used. You will also need two eyepieces, or oculars. One, which I will refer to as number

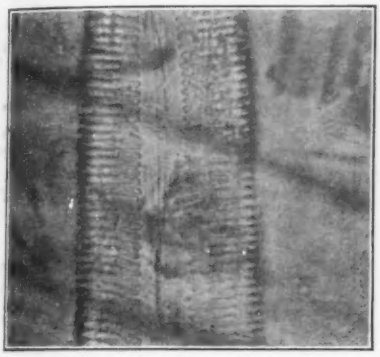
Human hairs cut transversely. Left view is magnified 675 diameters; right 1800 diameters

one, is an ordinary ocular magnifying between 10 and 15 diameters. The second, which I will call number two, is termed a "micrometer focusing eyepiece" and can be obtained in two powers, namely seven and 17 diameters. This can be purchased without the

more expensive micrometer attachment.

The following process for delicate work, and using the 17 power, number two ocular, is to be recommended.

Place the microscope, containing ocular number one, in the stand and focus in the regular way, using the eye. Now remove number one and substitute ocular number two. Place the camera, unloaded, on the stand and, without altering any of the former adjustments, focus sharply on the ground glass by carefully turning the upper part of ocular number two. When this has been done, remove the camera, load with film, replace and make the exposure.



A ribbed diatom, photographed using magnification of 675 times

Once these adjustments have been made, they need not be touched unless the magnification power of the microscope is altered.

When stained micro-organisms are to be photographed, the best results will be obtained with those stained red or brown, in preference to blue. This is particularly true if a color filter of the type known as K2 is employed.

There is a vast field open for experimentation in this line. The above is only a very brief resume of my work, and undoubtedly others will discover better methods than mine. To those that take up the work, let it be said that the results will depend on the amount of time expended. Experimentation with the time of exposure, color filters and focusing methods will reveal more definite data which can be followed for best results.—*Contributed by A. C. Lonert.*

Photograph of pollen grains from a rose, magnified 135 diameters

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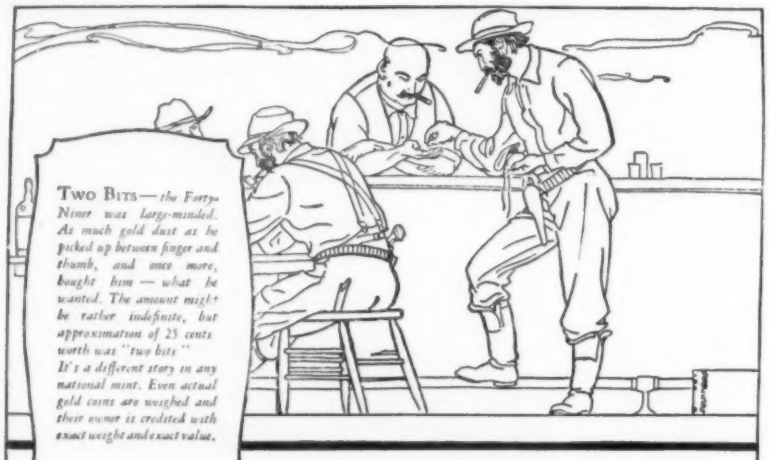

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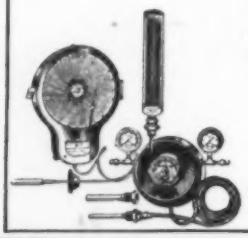

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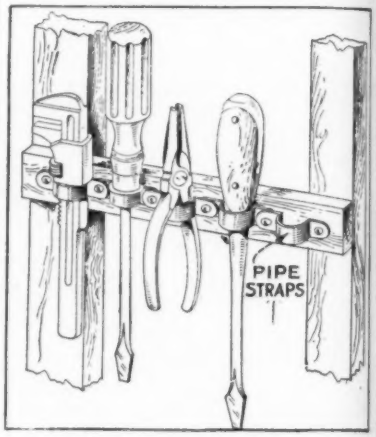
omitted, the names and addresses of companies that supply microscopes, special eyepieces, color filters and other supplies for the microscopist will be mailed upon request. *The Editor.*

Tool Rack

WRITING in *Power*, Mr. H. L. Wheeler, of Syracuse, New York, tells of a rack of small tools that is very easy to make and of great value in the workshop. Such a rack is illustrated in these columns, and the following paragraphs are what Mr. Wheeler has to say about the arrangement.



Tool holder made of pipe straps

"A rack made of miscellaneous sizes of pipe straps, as shown in the illustration, makes a handy resting place for small tools around the engineer's work bench. Such tools as screwdrivers, chisels and pliers, may be hung within convenient reach. Each may have its proper place where it will be on the job whenever needed.

"To make the rack, nail a piece of one by two inch board about ten inches higher than the bench. To this strip nail or screw the pipe straps, one lapping over the other. Provision can be made for many different small tools by using the several sizes of pipe straps."

Perspective Photographs without a Stereoscope

REFERRING to the item on stereoscopic photography in the March, 1927, issue of this magazine, Mr. George P. Sanborn sends an interesting item regarding the use of photographs produced by the described method, by means of which it is possible sometimes to do away with the usual stereoscope. The system, which the editor has tried out successfully on occassion, is described in the following paragraphs. It is well to note that all persons do not obtain the same effect, and that all stereoscopic prints are not suitable for the work.

As a preparatory measure, prior to trying a "double" or stereoscopic print, make two black dots about three inches apart on a white card. Hold the card a few inches from the eyes, and in such a position that a line connecting the dots will be parallel with a line connecting the eyes. Focus the eyes on an imaginary spot between the two dots

and some distance behind the card. Soon, if the conditions are right, the two dots will appear to coalesce, and *three* dots will appear—the third one, which is apparent and not real, about half way between the two actual dots. This effect shows that the trick has been acquired and you can now try a stereoscopic print.

When doing this, proceed in the same manner as described for the white card, using a print that has some particularly striking feature. When this feature on one of the prints appears to coalesce with the same part on the other print, the picture will appear to stand out in full perspective. Some practice will be necessary before the best results can be obtained.

Counterbalance Weight

I WANTED an accurate, presentable counterbalance for a ventilator door, as I did not wish to leave my experimental assortment of bits of iron hanging to the end of the pulley rope. Two old fruit-jar lids and a piece of discarded inner tube from an automobile were the essentials for a neater weight.

One end of the tube was tied securely over one of the lids. I then filled the tube with coarse sand until it weighed exactly as much as my trial conglomeration of iron. A hole was punched in the other lid, and a hook inserted. This was made of heavy wire with a circular spread below to distribute the weight over the inner surface of the cover. This cover was pushed down into the tube, expanding it to a straight cylinder and closely packing the sand. It was quickly made, "filled the bill," and I think was just a bit more neat, accurate, and safe than any other small counterbalance of its kind I have ever seen.

A counterbalance weight made of sand and a piece of inner tube

—Contributed by Frank W. Bentley, Jr.

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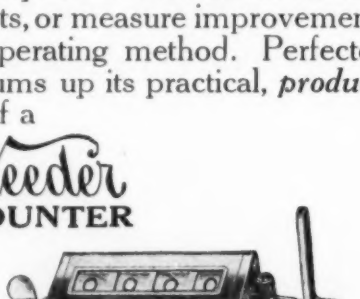
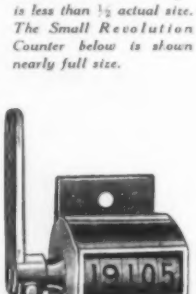
Veeder COUNTER

The large Set-Back Revolution Counter at right is less than ½ actual size. The Small Revolution Counter below is shown nearly full size.





The Set-Back Revolution Counter above records the output of the larger machines where the revolutions of a shaft record operations or output. Counts one for each revolution, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price, with four figures, as illustrated, $10.00 (subject to discount.)

The Small Revolution Counter at left records the output of smaller machines where a shaft revolution indicates an operation. Though small, this counter is very durable; its mechanism will stand a very high rate of speed, making it especially adapted to light, fast-running machines. Will subtract if run backward. Price, $2.00.

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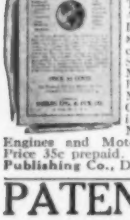

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In the World of Chemistry

(*Continued from page 76*)

this source is in a state of rapid development and investigations are being made of the efficiency of the by-product, glaucosil, as compared to other similar materials.

In reporting an investigation of the subject before the American Chemical Society, Whittaker and Fox of the Bureau of Soils state:

"Glaucosil is the siliceous residue obtained by extracting greensand with mineral acids, preferably sulfuric acid. The acid leach is treated to recover potassium salts, iron and aluminum oxides, and fuming sulfuric acid. Glaucosil is thus obtained simultaneously with other products and is, in short, a by-product of the manufacture of potash and other materials from greensand. The siliceous residue as obtained in the process contains only such salts as are present in the mother liquor and these are easily removed by washing.

"Glaucosil is practically pure silica. It differs from artificial active silica in that it has never been through the gel stage, unless perhaps it went through such a stage in the geological ages when the greensand from which it is derived was formed. It is simply the silica skeleton of the greensand granule, the surfaces of which, both inner and outer, have been cleared off and left in a highly active state by the action of the acid. It is never in solution, colloidal or otherwise, during its manufacture. Chemically it is quite active, much more so than any crystalline silica. It dissolves readily in dilute caustic by simple warming. Acids apparently leave it entirely unattacked."

After a careful study of the comparative adsorption of benzene, xylene, carbon tetrachloride and water by it, these investigators point out that glaucosil has a high activity and adsorption capacity as compared with other similar materials. They conclude from their investigations that the by-product of this new industry will find wide industrial application and compare the saturation values with those obtained by Munro and Johnson with aluminum oxide and by Patrick and Opdycke on silica gel. Saturated or nearly saturated vapors were used in each case. The accompanying table gives a comparison of the three adsorbents under test conditions.

Relative Adsorptive Capacity of Glaucosil, Aluminum Oxide, and Silica Gel

Adsorbent	Temperature	Adsorbed	
		Benzene	Carbon tetrachloride
	Degrees Centigrade	*Percent*	*Percent*
Glaucosil	25	40.5	61.0
Aluminum oxide	20	16.0	29.0
Silica-gel	30	24.6	44.9

Selenious Acid as a Weed Killer

DANDELIONS and other weeds, which cause the makers of lawns so much trouble, may yield to a treatment with selenious acid, a derivative of the metal selenium so often spoken of because of its changes in electrical resistance under the influence of light.

Norman W. Stover and B. S. Hopkins of the University of Illinois report on a recent investigation of the action of selenium and tellurium compounds on fungi and bacteria in *Industrial and Engineering Chemistry*, and add to their remarks these pertinent paragraphs on the control of weed growth:

"It would seem probable that, under normal weather conditions, selenious acid in a concentration of 0.005 normal could be used as a spray to check the growth of dandelions in lawns and yet not permanently injure grass.

"The results of similar work on other weeds may be summed up as follows: Canada thistle was killed by spraying in the late fall with 0.02 normal selenious acid, whereas summer spraying did not prove successful. Burdock was readily killed by 0.02 normal selenious acid by spraying in mid-summer. For plantain and pigweed, selenious acid in concentrations of at least 0.05 normal were required to actually kill the plants. The results of experiments on poison ivy were not definite."

Waste Sulfite Liquor as a Spray Material

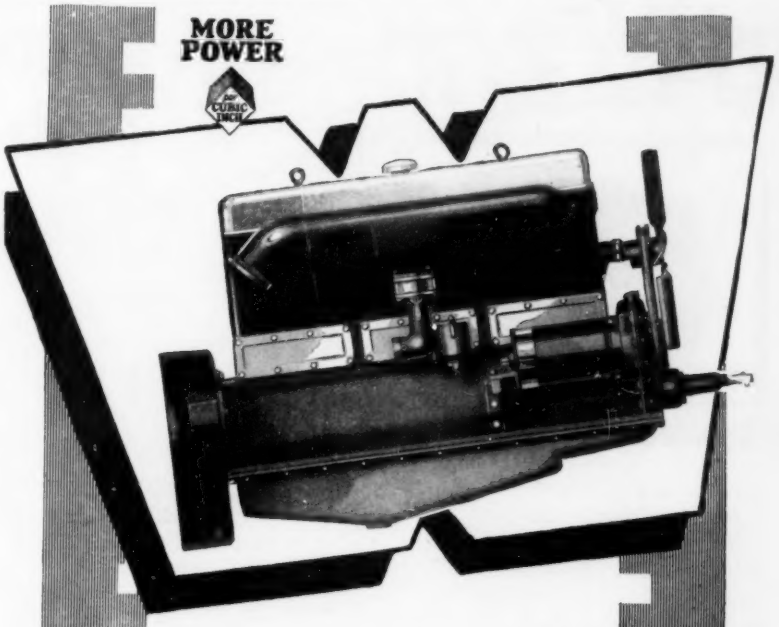
THE waste liquor from the manufacture of sulfite paper pulp is one of the largest single wastes of industry, and any possible use for it immediately attracts attention. The latest suggestion comes from C. S. Fleming and J. H. Reedy of the University of Illinois who report, in *Chemical and Metallurgical Engineering*, successful tests of its use as an insecticide and fungicide for agricultural use. Their process consists in saturating the liquor with hydrogen sulfide and using this as a spray after the chemical reactions have had time for completion. Such a solution is very similar to the standard lime-sulfur spray now widely used.

A Test For Pin Holes in Metal Coating

SOME time ago in this department a description was given of the so-called "ferroxyl" corrosion test. The application of this to practical purposes is rather difficult, and recently, in conversation with Professor Edwin M. Baker of the University of Michigan, we learned of a more convenient method of applying this test to the detection of pin holes in electroplates on iron work. A solution is prepared of two grams of potassium ferricyanide (red prussiate of potash) and ten grams of salt (sodium chloride), in 250 cubic centimeters of water. Strips of filter paper of convenient size are saturated with this solution and dried. These strips of filter paper can be kept indefinitely for use. To detect faults in nickel plated work, a strip of this paper is moistened and spread carefully over the sample in such a way that no air bubbles are retained beneath it. Pin holes show up within a very few minutes as blue spots on the paper. These spots are permanent and after drying the paper record of them can be preserved for reference.

Alcohol For Diluting Gasoline

FOLLOWING the precedent set by France, the Italian Government has decreed that all gasoline used in that country must be diluted with alcohol.



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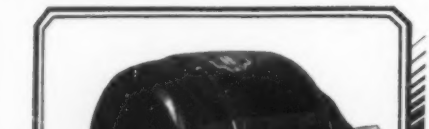
Send For This Motor And Make This Test



Any manufacturer of electrically driven devices who can reduce or eliminate vibration in his product has a distinct sales advantage. Vibration causes noise, bearing trouble, arcing and shortens the life of the product.

In Dumore motors vibration is eliminated by removing antagonizing weight from motor armatures on a specially designed machine. Consequently Dumore motors are in dynamic or running balance. They run smoothly, quietly and without perceptible vibration. The bearings stand up.

These facts can be demonstrated in an out and out comparison. We want you to *see* and *feel* the difference between a Dumore and any other universal motor (regardless of make).

Write us on your own letterhead and we will send you a stock motor on memo charge. When the motor arrives lay it on a level surface beside the motor you are now using, run them both at working speed, and, remembering the harmful effects of vibration, draw your own conclusions.

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Dynamically Balanced Universal Motors

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A Helicopter

AN interesting photograph of a helicopter which one of our readers has designed and built, is reproduced in these columns. We print below some details of the machine as furnished by the inventor.

Editor, SCIENTIFIC AMERICAN:

My helicopter may now be termed a partial success. On a recent test, I had some hard luck with it, stripping the transmission gears. This happened when I opened the throttle suddenly, and the machine had just started to rise from the ground. I am now changing the design of the wings, and will install a larger motor, whereupon I have great hopes for further success. The following paragraph gives some of the details of the present machine:

A Lawrence 28-horsepower motor is employed. The wings are of the Spad type, measuring 25 feet from tip to tip. The fuselage is 23 feet in length and the entire machine when empty weighs 750 pounds.

Yours very truly,
Leo Ortego.
Alexandria, Louisiana.

Used in Sermons!

JUST now, when anti-evolutionists are banging away at science, it is rather refreshing to receive word from a clergyman that he is using the SCIENTIFIC AMERICAN for obtaining ideas for use in sermons. A Jesuit priest in a remotely located parish writes us as follows:

Editor, SCIENTIFIC AMERICAN:

"It has been some years since I have come across the SCIENTIFIC AMERICAN in our Jesuit Colleges. Marooned here on a small island, and in a small parish residence, one has little chance to have many books for reading.

What is found in your magazine may come in handy by way of illustrations in sermons, conversation, et cetera.

I was agreeably surprised to find that the magazine had increased considerably in bulk.

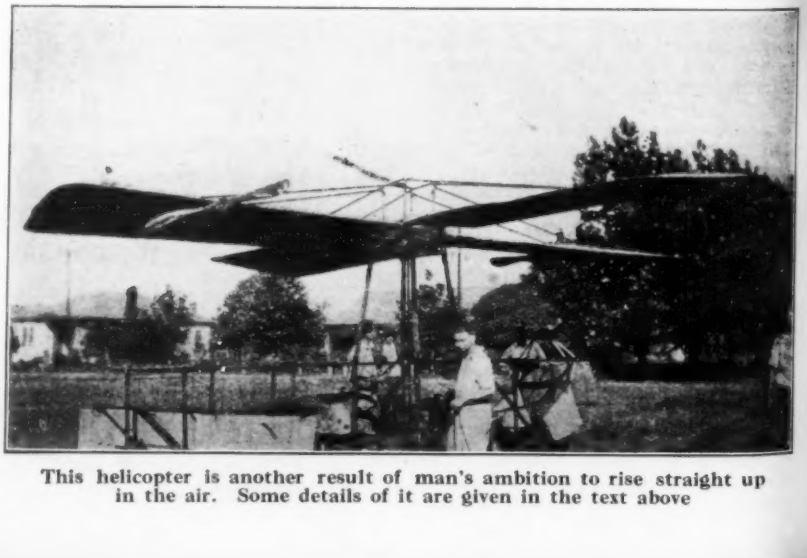
Sincerely,
Rev. A. L. Maureau, S. J.
St. Mary's Church, Star of the Sea,
Key West, Florida.

Venerable

THE SCIENTIFIC AMERICAN was founded in 1845 and is therefore read by life-long readers of all ages. Some who "formed the habit" years ago still keep it up. Here is a letter from an octogenarian who expects to read our pages 21 years more. May he be able to do so!

Editor, SCIENTIFIC AMERICAN:

I will be 83 years on the 29th of January, 1927, and after that date—should I live to be as old as my



This helicopter is another result of man's ambition to rise straight up in the air. Some details of it are given in the text above

grandfather Coombs was, I will then be 104 years old, or 21 years older than I am now.

I was told by reliable parties who knew my grandparents, the Clark and Bryant families, that my grandfather Clark and his wife lived a lifetime of a hundred years each, near Damacotta, Maine, and raised twenty children—all healthy.

I would ask, why have the healthy Christian men and women quit raising such families nowadays?

C. E. Clark,
Boise, Idaho.

P. S.—If I should live 21 years more you can count on me sending my subscription of four dollars in advance every year, because I would not like to miss a single issue of the SCIENTIFIC AMERICAN.

Science Teacher Makes Home-Made Telescope

IN these columns we reproduce a photograph of a reflecting telescope made by a physics instructor in the Fort Dodge, Iowa, High School. Science teachers who can thus demonstrate by means of their own handiwork that the things they are teaching are real instead

Mr. Bloxom and his reflecting telescope, made from cardboard tube and a rigid music stand

of mere "book science," must surely inspire their pupils with enhanced interest in their studies. Writes Mr. Bloxom:

Editor, SCIENTIFIC AMERICAN:

With the aid of your book, "Amateur Telescope Making," I succeeded in producing an interesting little telescope at an extremely small expense, and one that I find very useful in the study of astronomy and optics in my science classes.

The mirror was cut from ordinary plate glass and is four and one half inches in diameter, having a focal length of 44 inches. The tube consists of rigid cardboard formerly

6 Reasons Why

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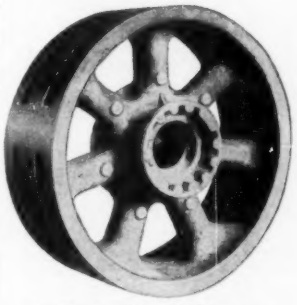

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3 out of 5 Steel Wheels Made Today are Daytons

Cases are on record where trucks were demolished in train wrecks, yet with their Dayton Steel Wheels coming through undamaged and ready for further service. That's the kind of strength you find in the patented Dayton Steel Wheel. Brute strength is just one of the reasons why 3 out of every 5 steel wheels made today are patented Dayton Steel Wheels. Specify them.

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Among products wanted are: Electrical devices; and those using small motors; products for machine shops or foundries, especially malleable or grey iron; scales; refrigerating devices; agricultural or other implements; railroad equipment; household products. Opportunities also for products not in the foregoing classification.

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used in shipping rugs, and all other parts are equally light. Notice the floating eye-piece arranged to be turned to different positions at leisure. Notice also that a laboratory clamp and a bent rod give hints of an equatorial mounting. The telescope is quite portable, weighing only 9¾ pounds complete.

It might be interesting to the amateurs to know that a tiny glass bead picked from a lamp shade and glued over the pin-hole served to diffuse the light from an unfrosted light globe for the purpose of testing the mirror according to Foucault's plan.

The SCIENTIFIC AMERICAN is doing much to encourage the study of science in the schools, and though this telescope is very modest in dimension, I have personally profited, both directly and indirectly, from the experiment. I began the project on a rainy day, not convinced of its wiles, but retaining the idea that sunshine might change my plans. Clear skies have strengthened my plans; I hope to build a ten-inch telescope soon. Lend my encouragement to the amateurs.

Very truly yours,
H. Lynn Bloxom.

Freak of a Storm

VIOLENT storms in various sections of the country frequently leave examples of their vagaries in various forms.

One freak result of a storm

Here is the record of another, as sent to us by one of our Texas correspondents:

Editor, SCIENTIFIC AMERICAN:

I am enclosing a picture taken in Rocksprings, Texas, shortly after the tornado of April 12, 1927.

Showing as it does the velocity of the wind that would crumple such steel—and also showing the freakish prank of the wind in not harming the wooden poles so near it—I believe that you will be able to use it.

Very truly yours,
Robert W. Jacobs.

Learning to Use Our Wings

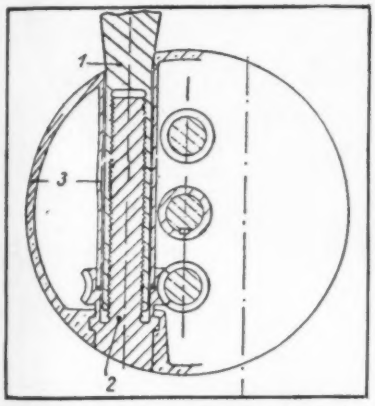
(*Continued from page 73*)

load, the air resistance of an airplane towing a string of gliders is likely to be greater than the air resistance of a single aircraft. The structural weight of the towing combination is also likely to be greater than the structural weight of a single airplane carrying the same pay load.

Unless the convenience of being able to discharge freight without landing proves to have great advantages, the experiment is likely to remain just a clever "stunt."

Propeller Design

WHEN an airplane is climbing, it is advantageous to reduce the pitch of the propeller, since the speed on the climb is much less than at maximum speed, while the revolutions per minute diminish only a few percent. At the same time it is advantageous to increase



This diagram is a cross-section of the hub of an adjustable propeller for airplanes. The action is described in the text below

the diameter, since this diminishes the slipstream velocity and the parasitic resistance of those parts of the airplane which are in the slipstream.

Hitherto, inventors and designers have confined their efforts to varying the pitch only. Propellers in which pitch could be varied in flight have been produced with a moderate degree of success, but on the whole it has been found more practical to design mechanisms in which pitch could be varied only on the ground.

The invention of M. G. Rouilleit, of Paris, recently described in *Les Ailes*, allows both pitch and diameter to be varied on the ground, and may therefore be of real value. The working mechanism shown in the sketch is rather briefly described, and the sketch itself is difficult to understand completely. It would appear that the airscrew blades terminate in a cylindrical part, 1, provided with an inner thread. The outer side of this cylindrical piece is provided with grooves which connect it with the propeller hub, 3. The spindle, 2, is connected with the hub by a cog, and also carries a worm which is driven by a worm-wheel. By turning the worm-wheel, the blades can be moved in and out at will with simultaneous variation of the pitch.

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The heavy non-skid blocks of rubber, stand out and assure a strong hold on any surface that will support the truck. The traction units are joined together by submerged ribs which stabilize the whole tread, giving maximum carrying capacity and insuring long mileage. Built on the Firestone patented brass plated steel base—assuring highest quality throughout. Call on the Firestone Service Dealer for performance facts about *Non-Skid Hi-Type Tires*, and details of the complete Truck Tire Service he offers.

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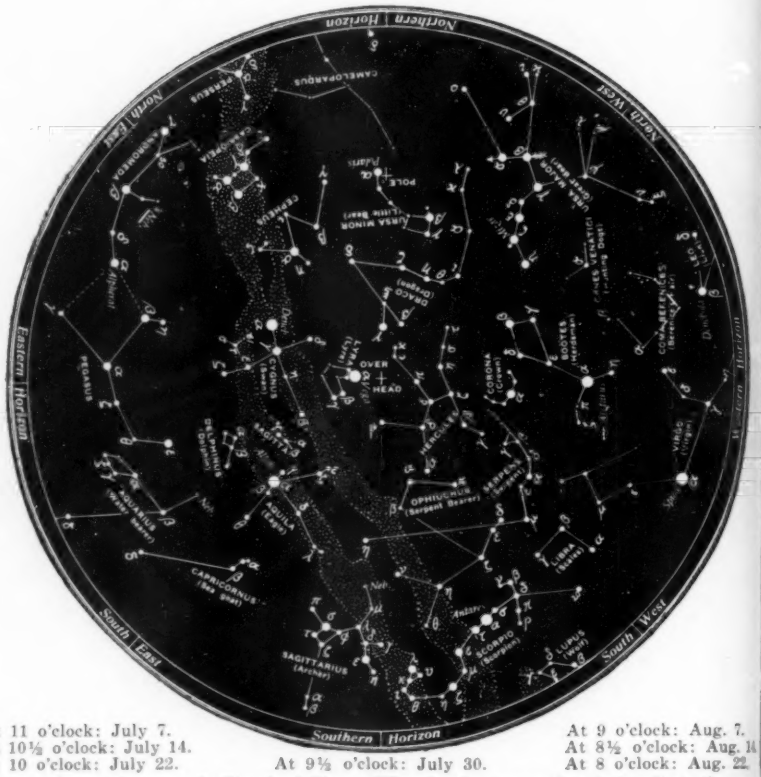
Describes in detail the history of Pisé, the kind of soil mixture most adaptable, and all the tools and forms necessary for anyone to build.

Scientific American

The Heavens in July

BY PROF. HENRY NORRIS RUSSELL, Ph.D.



At 11 o'clock: July 7.
At 10½ o'clock: July 14.
At 10 o'clock: July 22.
At 9½ o'clock: July 30.
At 9 o'clock: Aug. 7.
At 8½ o'clock: Aug. 14.
At 8 o'clock: Aug. 22.

The hours given are in Standard Time. When local summer time is in effect, they must be made one hour later: 12 o'clock on July 7, etc.

NIGHT SKY: JULY AND AUGUST

The Heavens

ON our star map this month, we find the bright star Vega almost overhead. Below it, to the southeast and high in the sky, is another bright star, Altair, flanked by a fainter one on each side. To the left, due east and high up, is the constellation Cygnus, sometimes called the "Northern Cross," and looking much more like a cross than the southern constellation of that name. Its brightest star, Deneb, looks a little fainter than Altair, and much inferior to Vega, but it is in reality very much brighter than either, and would altogether outshine them if it were not exceedingly far away in space.

Farther to the left, and still following the Milky Way, we find Cepheus and Cassiopeia. Below these galactic constellations appear Pegasus and Andromeda. The Great Nebula in the latter —which can readily be found with the aid of the map—is so remote that Deneb itself, if equally far away, would probably be visible only in the most powerful telescopes.

The Planets

Mercury is an evening star until the 20th, when he passes through inferior conjunction and becomes a morning star.

Venus is an evening star, and at her best, being at her maximum apparent distance from the sun on the 2nd. She does not set until after 10 P.M. and is by far the most conspicuous object in the sky. With even a small telescope her half-moon phase is easy to see.

Mars is an evening star like the others, but is getting pretty well down. He sets about 9 P.M. and looks about as bright as the Pole-star.

Jupiter is past quadrature, and is due south about 5 A.M. in the middle of the month. Saturn is in Scorpio and well visible all the evening. Uranus is in Pisces, and is in conjunction with Jupiter on the 9th, being 38 degrees north of him. This will make it easy to pick the planet up with field-glasses.

The moon is in her first quarter at 8 P.M. on the 6th; full at 2 P.M. on the 14th; in her last quarter at 10 A.M. on the 21st, and new at 1 P.M. on the 28th. She is nearest the earth on the 19th, and farthest away on the 6th.

During the month she passes near Mercury on the 1st, Mars, Neptune and Venus on the 2nd, Saturn on the 10th, Uranus and Jupiter on the 19th, Mercury again on the 27th, Neptune on the 30th and Mars later on the same day. There are therefore no less than ten planetary conjunctions with the moon this month, while last month there were only six.

Saturn is occulted at this conjunction, and the occultation is visible in the United States. As seen from Washington, the planet disappears at 4:30 P.M. and emerges at 5:31. Unfortunately, this happens in the daytime, so that a good telescope will be needed to see the phenomenon.

Our Choice of Recent Books

TOMB OF TUT-ANKH-AMEN, VOL. II.

By Howard Carter

'Man is but a child matured,' for we all love stories of adventure, particularly treasure trove. No fiction, however, has ever approached the prospecting, unearthing and inventory of the find in the Theban hills in 1922 by Lord Carnarvon, Howard Carter and our own experts of the Metropolitan Museum, Mace and Burton. The first volume, of which a few copies are still available, carried through the preliminaries to the opening of the inner sealed door of the sepulcher. The present volume records the fabulous treasure inventoried and preserved during the short third and entire fourth seasons. Most interesting appendices describe in detail the mummy, the various materials found, the floral wreaths and the analysis of various items including some of the methods of preservation and handling.

The Macmillan Company, $5.20 Postpaid.

ELEMENTS OF CHEMISTRY

By H. N. Holmes, Prof. of Chemistry, Oberlin, L. W. Mattern, McKinley Tech. High School.

In the words of the authors, "Interest is the salt that makes a student knowledge thirsty. This book has been written with the avowed intention of first capturing interest and attention and then leading on to scientific thinking." To stimulate proper continuity of thought, related chapters have been grouped together, as for instance, air nitrogen, ammonia and nitric acid, etc.

The Macmillan Company. $1.95 Postpaid.

REWINDING SMALL MOTORS

By D. H. Braymer and A. C. Roe

There has been a need for practical information on winding procedure for fractional horsepower D.C. and A.C. motors, such as those on portable drills, grinders, automobile starting motors, etc. This practical man's handbook meets the need in a most admirable way with as little technical information as required to understand the procedure indicated.

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MOLE PHILOSOPHY

By C. J. Keyser, Prof. of Mathematics, Columbia.

No book that we have listed along the line of what one may call humorous philosophy, has had the popularity of this author's "Thinking About Thinking." He now adds another volume which he describes as written "to purge my mind of certain precipitates of experience and meditation." With a mind keen for analysis and a humor that holds the reader by its human conclusions, Prof. Keyser lists himself among the few who can write to the heart of things.

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WIRELESS PICTURES AND TELEVISION

By T. Thorne Baker

Tracing carefully the ground of advance during the last twenty years, the author establishes the basis upon which is founded the remarkable television demonstrations recently accomplished. Simple diagrams and few formulae make the text understandable to the layman. A very timely and pertinent issue for those who wish to know something of the fundamentals of this development.

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PRINCIPLES OF PETROLOGY

By G. W. Tyrrell, Lecturer Geology, University of Glasgow

A concise and novel treatment which covers the whole field of rocks in a way especially suitable for students. Modern views built on the underlying basis laid by the older generation of petrologists and a wide range of reading references will recommend this work to those who have acquired an elementary knowledge of the science.

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RADIO TELEGRAPHY AND TELEPHONY

By Rear Admiral S. S. Robison, U. S. N. Commander S. C. Hooper, U. S. N. Lt. Commander T. A. M. Craven, U. S. N.

The fact that this is the seventh revised edition will vouch for the authoritativeness of this manual which is used by Naval Radiomen. A thorough consideration of basic principles.

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SILVER CITIES OF YUCATAN

By Gregory Mason

A personal narrative of the Mason-Spinden expedition telling with an unusual degree of interest the many adventurous incidents which were a part of this important scientific expedition. Illustrated with good photographs of the interesting "finds."

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WHALE SHIP BOOK

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The distinguishing details of old time whale ships shown by numerous sketches, without dimensions, and photographs of various models. Detailed scale drawings of the good ship *Alice Mandell* are pocketed in the inside back cover.

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STREAMCRAFT

By G. P Holden

A revised edition which covers many of the fine points of making and repairing flies, together with an extended consideration of tackle and gear of all sorts. Colored plates also illustrate many varieties of trout flies.

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Commercial Property News

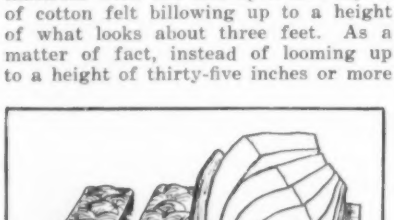
A Department of Facts and Notes of Interest to Patentees and Owners of Trademark Rights

CONDUCTED BY MILTON WRIGHT

Exaggeration is Excusable

THAT the Federal Trade will get you if you try to deceive the public is well known. But what if you merely exaggerate the qualities of the products you are selling? That, the courts believe, is a time-honored custom with which no fault can be found.

The recent experience of Ostermoor and Company is a case in point. The Ostermoor trademark is a picture of a mattress with one end open and layers of cotton felt billowing up to a height of what looks about three feet. As a matter of fact, instead of looming up to a height of thirty-five inches or more



This type of exaggeration is permissible in trademark registration

when opened, an Ostermoor mattress expands only from three to six inches. The mark has been in use about 30 years and more than 4,000,000 dollars has been spent in advertising it. The Federal Trade Commission called the use of the mark in advertising misrepresentation, falsity and deception amounting to unfair competition and ordered the company to stop using it. The case went up to the Circuit Court of Appeals for the Second Circuit.

"The time-honored custom of at least merely slightly puffing, unlike the clear misrepresentation of the character of goods, has not come under the ban," Judge Mack finds. "Concededly it is an exaggeration of the actual condition; indeed petitioner asserts that it is not and was not intended to be descriptive, but fanciful and, as such, the subject matter of valid trademarks.

"It is unnecessary to determine many questions sought to be raised, among others, whether the proceeding is in the public interest, in the light of the fact that petitioner does less than 1 percent of the mattress and cushion business of the country, that hundreds of competitors use similar advertising pictures, that petitioner and its predecessors have established a high reputation and have always fulfilled their guarantee to make good any complaints, or to what extent the use of otherwise valid trademarks in unfair competition may be forbidden. The determination of validity or invalidity of the picture as a trademark, because fanciful or merely descriptive, is not within the jurisdiction of the Commission or of this court in this proceeding. The sole inquiry here is that of unfair competition against the public interest.

"In our judgment, this pictorial representation of the process of manufacturing Ostermoor mattresses and of the materials used therein, even though exaggerated as to their characteristics, cannot deceive the average purchaser and the record is practically bare of any evidence of actual reliance upon the puffing exaggeration of qualities. There is no basis for the finding that 'substantial numbers of purchasers had been misled and deceived by the grossly exaggerated pictorial representation.'

"Finding no evidence of unfair competition, the order of the Commission is annulled."

The picture on the Ostermoor trademark, incidentally, is public property, the Court of Appeals of the District of Columbia having so held several months ago.

Old Claims in New Applications

CAN one take an element of this patented invention, an element of that and an element of a third, put them all together and get a new patent on the new aggregation?

No, unless, of course, the various features work in a new way in the contrivance. The mere fact that the device will accomplish better results than devices which went before will not justify the issuance of a patent.

So Lewis Fine has discovered, whose application for a patent on a vehicle wheel construction has been denied an appeal by the Patent Commissioner. In refusing a patent the Commissioner says:

"The applicant has submitted, in connection with his brief, a showing of how the various strains to which a construction of this character is subjected in use are resisted. The fact is noted by applicant that all his features are not bound in a single anticipating structure and that, in consequence, each of the devices of the prior art is open to some objection.

"It may be said that the applicant has done no more than pick out from three patents, two to Putnam and one to Simmons, the three features which appealed to him as possessing the greatest mer. uniting them in just the

Patents Recently Issued

Classified Advertising

Advertisements in this section listed under proper classifications, rate 25c per word each insertion: minimum number of words per insertion 24, maximum 60. Payments must accompany each insertion.

Official copies of any patents listed in this section at 15c each; state patent number to insure receipt of desired patent copy.

Pertaining to Aeronautics

PROPELLER.—For airplanes, rotated by means of the reactions effected by passing a fluid medium through the blades, or by the use of an internal combustion motor. Patent 1626424. W. W. Paget, 3121 Bayo Vista Ave., Alameda, Calif.

AIRPLANE LAUNCHING AND LANDING APPARATUS.—Including a platform which is capable of elevation to an appropriate height for facilitating the launching and landing of aircraft in restricted places. Patent 1625,020. F. G. Diago, Box 1972, Habana, Cuba.

AIRCRAFT.—Having lifting apparatus which causes the craft to ascend after the manner of a helicopter, and a second means for causing the translatory movement of the craft. Patent 1625646. F. Geddis, c/o Mrs. C. Groves, 371 5th Ave., Brooklyn, N. Y.

Pertaining to Apparel

COMBINED CORSET AND BRASSIERE.—The parts so connected as to present a substantially uniform appearing garment, each garment functioning independently, the corset acting to hold down the brassiere. Patent 1625664. J. J. Kispert, c/o I. Newman & Sons, 17 Oak St., New Haven, Conn.

METHOD OF PRODUCING APPAREL ORNAMENTS.—Such as frogs and like garment fastening having a plurality of loops formed from a continuous strip without crossing of the corded braid. Patent 1624805. A. Rosenberg, 152 E. 3rd St., Brooklyn, N. Y.

GARMENT ATTACHMENT.—Adapted for use with wearing apparel, for removably securing a fountain pen or the like, within a pocket, by means of a resilient clip. Patent 1621826. P. T. Burtchaell, 630 4th St., San Rafael, Calif.

CORSET.—Partly made of elastic material, and particularly cut to provide means for preventing the upper front portion projecting away from the body. Patent 1623031. Blanche Carvelli, 311 Pacific Bldg., San Francisco, Calif.

REMOVABLE HALF-SOLE FOR SHOES.—With clamping means adapted to be snugly fitted over the edge of a permanent sole which will look and wear as an ordinary half-sole. Patent 1627465. A. S. Simko, 92 3rd St., Passaic, N. J.

Chemical Processes

PAINT COMPOSITION.—For coating walls of brick, stone or concrete, and for protecting timbers of any kind. The composition com-

way they have been used before in a single wheel.

"There is not believed to be any new or combined result present but merely the aggregate results that were obtained in the old structures.

"While applicant objects to the citation of three patents against his claim, I am aware of no adjudicated case which limits the number of references that may be presented to anticipate a claim. Indeed, the selection of old devices from the prior art and the placing of them in a single or unitary structure may, in a given case, go on indefinitely without the production of anything patentable.

"It would seem the applicant in his construction has not combined the parts heretofore found in separate patents but has merely used them as separate parts of his device to accomplish the functions in the way revealed by the prior art.

"As to the claims copied from the patents, it is not believed any error has been made in the holding that applicant is not entitled to make them."

You Cannot Patent a Function

YOU may obtain a patent for a machine, but not for the machine's functions. This well-settled but often misunderstood principle of patent law is illustrated by the decision of the Examiners-in-Chief in denying the application of Green Carlton Hosch, whose improved shutter for a measuring machine chart already had been issued. An appeal was taken from the rejection of some of the claims. Quoting a prior decision by the Commissioner, the Board says:

"It is well-settled law that a patent cannot issue for a result sought to be accomplished by the inventor of a machine, but only for the mechanical means or instrumentalities by which that result is to be obtained. One cannot describe a machine which will perform a certain function, and then claim the function itself and all other machines that may be invented by others to perform the same function."

A Complete Trade Reversal

IN one respect, at least, the United States has lost its trade balance in the last 20 years. Two decades ago we were an important exporter of forest products; now we have become a preponderant importer of lumber, pulp wood and associated materials.

Our total forest-products exports in 1906, with the exception of furniture and containers holding other merchandise, were 2,640,000,000 board feet; our imports of wood products were the equivalent of 1,651,000,000 board feet, leaving an excess of exports for that year of 989,000,000 board feet.

Last year, according to the Department of Commerce, our trade was completely reversed. Our exports amounted to 3,623,000,000 board feet, against imports of wood products equivalent to 6,689,000,000, thus registering an import balance of 3,623,000,000 board feet.

Round Ends for Neckties

THE Franklin Knitting Mills, Inc., are entitled to a monopoly in knitted neckties with round ends, according to a recent decision by the United States Supreme Court denying a petition for a writ of review by the Gropper Knitting Mills, Inc. The Franklin company had won its suit for infringement of its design patent for an "ornamental design for a knitted necktie" which tends to prevent the end of the tie from becoming unraveled.

Originally the suit was dismissed by the District Court for Southern New York, on the ground that the patent was invalid for lack of novelty and invention. The Circuit Court, in reversing this decision, held that in a design patent it is immaterial if the design is hidden from the eye of the wearer. It was on the claim that a design must be visible that the Gropper Mills sought a review of the decision.

PROCESS FOR THE PREPARATION OF CUCURBOCITRIN.—A drug produced from the seed of "Cucurbita Citrellus" or watermelon, the product being efficacious for the reduction of high blood pressure. Patent 1626321. I. S. Barksdale, c/o Health Dept., Greenville, S. C.

TOBACCO WAX AND PROCESS FOR PRODUCING THE SAME.—Which comprises bleaching the tobacco in water at a temperature below 212°, F., for 48 hours; the substance extracted is fire-proof and usable as an insulation. Patent 1624155. S. Amster, Red House, Ky.

PROCESS OF AND APPARATUS FOR CONDENSING, TREATING AND WASHING HYDRO-CARBON VAPORS.—Apparatus for condensing, treating and washing hydro-carbon vapors, in which water is given a whirling movement and the vapors introduced thereinto. Patent 1627431. C. L. Freeland, Bristow, Okla.

Designs

DESIGNS FOR WOVEN FABRIC.—Patent 72487. E. Meyer, 39 Worth St., New York, N. Y.

DESIGN FOR A DRESS.—Patent 72501. M. Siegel, c/o Franklin Simon & Co., 38th St. and 5th Ave., New York, N. Y.

DESIGN FOR A BELT FOR PERSONAL WEAR.—Patent 72432. I. Leibovitz, c/o S. & L. Belt Co., 105 Wooster St., New York, N. Y.

DESIGN FOR A COMBINED BATHROOM FIXTURE.—The inventor has been granted two patents, 72543 and 72544. J. H. Balmer, 259 Plane St., Newark, N. J.

DESIGN FOR A DRESS.—Patent 72531. M. Siegel, c/o Franklin Simon & Co., 38th St. and 5th Ave., New York, N. Y.

DESIGN FOR A STOCKING.—Patent 72365. R. F. Friedrich, c/o Weber & Friedrich Co., 16th St. and Hunting Park Ave., Philadelphia, Pa.

DESIGN FOR A PRINTED FABRIC.—Patent 72378. J. H. Mack, c/o N. Lowenstein & Sons, 40 W. 23rd St., New York, N. Y.

Electrical Devices

LOW-CAPACITY FUSE.—In which the fuse wires are connected in a manner to provide good electrical connection, effecting a quick break when the fuse operates. Patent 1626105. E. V. Sundt, 4527 N. Ashland Ave., Chicago, Ill.

ELECTRIC SWITCH.—A combined clock and switch, which will automatically close the electric circuit of an automobile parking light at a predetermined time. Patent 1624120. J. E. Springer and R. A. Harry, 2837 Pressbary St., Baltimore, Md.

FLASH LIGHT.—Which employs a generating means operable by a spring motor, controlling the speed within defined limits for increasing or decreasing the intensity of the light. Patent 1624686. R. J. Smith, c/o The Bat-Les Lite Co., 8 Hubbert St., Albany, N. Y.

FUSE PLUG AND RECEPTACLE.—Constructed to preclude the introduction of a metal conductor such as a penny, or metal strip, between the lower and central contracts of the plug receptacle. Patent 1624030. R. H. Williams, c/o United Electric Co., 314 Fulton Ave., Evansville, Ind.

COMBINATION TERMINAL.—For electrodes of electric apparatus, whereby a spring terminal may be readily mounted on a carbon stick and held firmly in operative position. Patent 1627447. J. J. Mucher, 285 North 6th St., Brooklyn, N. Y.

RHEOSTAT.—Wherein mercury or other

The Patented Bouillon Cube

DID it ever occur to you that a little bouillon cube is a patented article? Not only has it been patented, but the Federal District Court for Southern New York recently has held that the patent owned by the American Kitchen Products Company is infringed by cubes of meat and vegetables manufactured by Steck and Steck.

"The great number of prior patents disclose that those schooled in the art had been seeking in vain to effect what the inventor finally accomplished," says Judge Bondy, in writing the opinion of the court. "The cubic unit rations at once became commercially popular and apparently supplies a larger demand. Four million cubes have been made and sold by the plaintiff since 1909 and royalties amounting to a very substantial sum have been paid or credited to the inventor under the patent in suit. The defendant urges the lack of invention in view of prior disclosures. None of these, however, discloses the same ingredients, the same process and the same product as plaintiff's.

"In reply to a letter written by the plaintiff, January 12, 1912, giving notice of the infringement of plaintiff's patent, defendant's attorneys did not deny infringement but stated that they doubted the validity of the patent.

"In 1914 the plaintiff brought suit against a most resourceful infringer. Its prosecution was delayed because it was impossible to get the testimony of necessary witnesses in Germany during the war. On May 3, 1921, a decree in that suit was entered on consent, sustaining the patent and holding it infringed.

"On July 22, 1921, another suit was brought against another infringer who likewise consented, October 5, 1922, to a decree sustaining the patent and holding it infringed.

"On February 14, 1924, suit was brought against the defendant. There is no proof that defendant changed its position or was prejudiced in any way by reason of the delay in bringing suit against it. Under the circumstances, the court cannot find that plaintiff was guilty of such laches in delaying to bring action against the defendant as to deny it protection.

"There is no evidence that the defendant did use the ingredients specified in the patent in suit substantially in the way described in the patent, and that the product sold by it was the same as plaintiff's product."

current conductive liquid serves as a current connecting medium between a resistance coil and a conductor. Patent 1625703. E. H. Bobo, 431 Bobo Ave., Ranger, Texas.

Of Interest to Farmers

CALF-WEANER.—Provided with means consisting of flaps inclined at an angle, readily inserted in the calf's nose, and fastened in place without harming the calf. Patent 1626090. G. M. Krauss, Rock Eagle Route, Lingle, Wyoming.

GARDEN CULTIVATOR.—In which the ground-digging tools are disposed in two sets, controlled by the left hand, and right hand, of the operator or operated simultaneously. Patent 1625829. S. W. Shaw, Galesburg, Kans.

IRRIGATING HYDRANT.—For farm irrigation, adapted to supply and control streams of water to any desired number of field furrows. Easily taken apart for cleaning. Patent 1624317. C. E. Crownover, 549 Ladd Ave., Portland, Ore.

EVAPORATION METER.—Designed for use in incubators, using an ordinary test tube in a holder upon which the scale is so inscribed that it may be easily read. Patent 1625310. R. L. Gilles, c/o Evapometer Co., Fargo, N. D.

MOISTURE GUIDE FOR INCUBATORS.—Which serves to provide the operator with a direct and accurate reading, showing the rate and amount of evaporation actually occurring. Patent 1625420. C. T. Patterson, c/o The Moisture Guide Co., Springfield, Missouri.

GRAIN WASHING AND DRYING MACHINE.—Wherein the grain is thoroughly washed, polished, aerated, tempered and dried, so as to be properly conditioned for milling purposes, without breaking the grain. Patent 1624831. D. Geddes, c/o Ingeneiro de Molinos Harineros, Guadalajara, Jalisco, Mex.

SPADING DEVICE.—Adapted to dig into the ordinary earth with due pressure, but when striking a stone or obstruction, the spade will be released to prevent its breaking. Patent 1624610. O. A. Matson, 5351 N. Paulina St., Chicago, Ill.

Of General Interest

VANITY-CASE-COMPACT HOLDER AND CATCH.—Wherein the holder may be formed as a solid or divided ring, with bent portions presenting a corrugated surface for gripping a compact. Patent 1626413. W. G. Kendall, 118 Market St., Newark, N. J.

WINDOW CLEANING DEVICE.—Especially adapted for cleaning outside surfaces of window panes, one type being used for the washing operation and a second type for drying the surface. Patent 1628593. M. Hayes, 180 Sterling Place, Brooklyn, N. Y.

MARKING DEVICE.—Which enables the operator while wearing a skirt to evenly mark on the same a line indicating a predetermined distance from the floor. Patent 1626440. R. Wasserman, 57 W. 124th St., New York, N. Y.

BATH MIT.—Constructed for bath and shampoo use; having two compartments with a hose connection for a constant supply of water. Patent 1619180. A Benussi, 445 Lafayette Ave., Brooklyn, N. Y.

FLUSHING TANK.—Which is extremely quiet in its operation, especially designed for places where water pressure is low; may be installed after the tank is set. Patent 1625311. N. J. Gondolf, 703 State St., New Orleans, La.

ATTACHMENT FOR BEVERAGE MIXERS.—Having means for modifying, when required, the temperature of a beverage either preparatory, subsequently or during the mixing operation. Patent 1623535. C. Ferguson, c/o Marine Hospital No. 43, Ellis Island, N. Y.

DISPLAY EASEL AND TRAY.—With clamps adapted to support articles, such as cutlery, and pictorial representations indicating the particular piece of cutlery to be placed therein, from the tray. Patent 1625647. G. C. Gillan, c/o The Ontario Knife Co., Franklinville, N. Y.

PACKING FOR GATE VALVES.—Such as are used in connection with water and gas mains, which will be practically self-packing, and will facilitate in the making of repairs. Patent 1625698. W. H. Barton, 30 Park St., Montclair, N. J.

CANOPY HOLDER.—Of the collapsible type, which may be conveniently transported in very small space, and easily placed in operative position to support a mosquito netting. Patent 1625673. V. P. Nelson, 264 Lexington Ave., New York, N. Y.

SEDIMENT TRAP FOR BOILERS.—Which may be readily attached to new or old domestic boilers, allowing the sediment to be trapped in a storage chamber and readily removed. Patent 1625709. F. Conrad, 109 Elm Ave., Bogota, N. J.

CONTAINER.—Provided with a mounting and hanger to be positioned at a convenient height for supporting a glass container, so that liquids may be readily dispensed therefrom. Patent 1624830. R. F. Emsley, 4228 Wooster Road, Rockey River, Ohio.

PNEUMATIC PAD.—Particularly designed as a saddle pad, collar pad or the like, functioning to afford a cushion between the harness and the animal, to ease strain. Patent 1624807. J. A. Schinner, P. O. Box 222, Greenville, Ohio.

TABLE.—Carried by a single standard or pedestal, and provided with means for adjusting the top to insure its positioning in a horizontal plane. Patent 1624770. R. J. Stuart, c/o Clarence J. Drake, Market and Cannon St., Poughkeepsie, N. Y.

METHOD OF FILLING TREE CAVITIES AND THE FILLING ITSELF.—Which will fit tightly against the walls of the cavity, be proof against destructive insects, and provide an affinity to the characteristics of the tree in its natural expansion and contraction. Patent 1624820. G. Van Yahres, Rutland St., Westbury, L. I., N. Y.

COMBINED COVER AND STRAINER.—Having means whereby it may be readily associated with or disassociated from a utensil, and adapted for use with utensils of various sizes. Patent 1624745. F. W. Kuhnast, 1537 St. Lawrence Ave., Bronx, N. Y.

NURSING-BOTTLE HOLDER.—For supporting a bottle from a carriage, bassinet, or the like, whereby the same may be readily shifted to various positions, and eliminates manual holding. Patent 1624695. A. Tufenkjian, 1373 Boulevard, West New York, N. J.

POLISHING COMPOSITION.—Comprising finely divided zinc dust, pumice and oil, especially adapted for polishing and graining metal surfaces, and photo-engravers' plates. Patent 1624783. A. B. Fisher, 16 Steuben St., Brooklyn, N. Y.

LOOSE-POWDER CONTAINER.—In which the powder is held about a central opening and directed thereto by the depression of a diaphragm normally closing the opening. Patent 1624874. S. S. Radley, c/o Evans Case Co., No. Attleboro, Mass.

GYROSCOPIC STABILIZER.—Employed in conjunction with the mountings of instruments, such as headlights, searchlights, cameras, or the like, for holding them relatively stationary. Patent 1621815. C. E. Schueller, 908 Ordway St., Berkeley, Calif.

WINDOW-SASH ATTACHMENT.—In the form of bars running through guide means on the lower sash, whereby the upper window may be raised and lowered within convenient reach. Patent 1620817. H. Huyard, 248 Whitney St., San Francisco, Calif.

HAIR-WAVE COMB.—Having hair-engaging members which co-act to produce a novel arrangement of waves, the strands being grouped in piles. Patent 1624757. G. B. O'Connor, 691 Bergen Ave., Bronx, N. Y.

HEADGATE.—Adapted to effectively control the passage of water to the mains and laterals of an irrigation system, and firmly held to prevent displacement. Patent 1621,748. W. Murdock, Deeth, Nevada.

DISPENSING CABINET.—In which the displays are so placed that the comparatively old supply will be presented for vending ahead of the latest supplies. Patent 1621,971. R. C. Curtis, Box 184, Martinez, Calif.

HAIR WAVER.—Whereby a double wave in the hair can be very readily produced, which gives a perfectly flat marcel wave effect, in a minimum of time. Patent 1618144. M. Banach, c/o Raven Beauty Shop, 2664 Grand Concourse, Bronx, N. Y.

RECEPTACLE.—Which can be stamped out of sheet metal, the edges being formed into a bead free from recesses or roughness, thus rendering the device sanitary. Patent 1624,273. D. C. Murphy, Box 626, Scobey, Mont.

HAM PRESSER.—Whereby a piece of ham may be conveniently inserted into a two-part container and compressed for subsequent cooking, the container and press being easily disconnected. Patent 1624808. G. W. Scholten, 708 Linn St., Muscatine, Iowa.

DOLL HEAD.—Having a series of tufts, simulating hair around the head, which in combination with the surface ornamentation, give the impression of a pickaninny. Patent 1627511. R. A. Hope, c/o Averile Mfg. Co., 143rd St. and Wales Ave., New York, N. Y.

BIRD PERCH.—Easily placed in position against a support, and easily removed for cleaning; constructed with smooth surface, preventing injury to the bird or his feathers. Patent 1627448. C. W. Mueller, 1089 Summit Ave., Jersey City, N. J.

MEANS OF FIXING ARTIFICIAL HAIR DRESS ON NATURAL HAIR.—Which may be used in dressing either long or short hair, consisting essentially of a wire spiral, of thin steel, of low pitch and short diameter. Patent 1627469. E. Syptroth, c/o Gustave Sattler, 12 W. 50th St., New York, N. Y.

METHOD OF SAND-BLAST RELIEF-CARVING.—Whereby flowers or other configurations may be carved on stone by sand-blast to produce a substantially life-like appearance in relief. Patent 1627456. G. R. Philip, c/o Cross Bros. Co., Northfield, Vt.

LINE-DRYING ATTACHMENT FOR FISHING RODS.—Which may be easily attached to a rod for drying the line as it is reeled in, thus preventing water dropping on the hands or clothes. Patent 1627514. L. Kraemer, 6 Hancock Rd., Homefield, Yonkers, N. Y.

CIGARETTE HOLDER.—Capable of being supported on a finger of the hand, permitting the free use of the other fingers without discoloring the fingers. Patent 1627463. M. J. Russak, 7033 Link Court, Maspeth, N. Y.

COLLAPSIBLE TENT SUPPORT.—For the ordinary form of three pole tent, including a pair of uprights, and ridge pole occupying a minimum amount of space when not in use. Patent 1627546. W. S. Ryerson, Edmonds, Wash.

HAND BAG.—Of the envelope type, so constructed that there is no danger of losing small articles no matter how carried, provided the flap is in closed position. Patent 1627496. E. Elias, 38 W. 32nd St., New York, N. Y.

GAS-MAIN STOPPER.—An assemblage comprising a collapsible frame having a diaphragm, adapted to be passed through an opening in the main and then expanded. Patent 1627502. P. Goodman, 523 Atlantic Ave., Brooklyn, N. Y.

STEAM TRAP.—Wherein the water is continuously discharged from the trap without danger of steam escaping. Patent 1627271. F. A. Burrows, c/o F. A. Burrows Mfg. Co., York, Pa.

RAZOR CASE.—For use with various styles and sizes of razors, and is adapted to oil and condition the blades when they are not in use. Patent 1615396. C. D. Lorenz, 616 Mills Bldg., El Paso, Texas.

Hardware and Tools

ELLIPSOGRAPH.—By means of which ellipses and ovals of various sizes and proportions can be drawn or inscribed in an accurate manner. Patent 1626430. A. C. Sanders, c/o Quality Engraving Co., 12 W. 9th St., Erie, Pa.

COMBINATION LEVEL.—Wherein two level elements are used, to act at various times as a line level, a surface level, and as an angle finder. Patent 1624684. E. W. Smith, 241 E. 25th St., New York, N. Y.

COMBINATION LOCK.—Which may be readily applied and readily opened by one familiar with the combination, particularly applicable as a chain lock. Patent 1627462. F. D. Rohmer, 401 Valley St., Lewistown, Pa.

TOOL.—With means whereby it can be used for several purposes, such as a cold chisel, an ordinary wrench, a spanner wrench, or for engaging nuts. Patent 1627,435. J. A. Hooben, 349 Bay St., Taunton, Mass.

STATIONARY-WASHTUB COVER FOLDING DEVICE.—A flexible element anchored to the wall, having a hooked member for retaining the cover of a washtub in raised position when in use. Patent 1627476. J. H. Barrett, 312 E. 93rd St., New York, N. Y.

Heating and Lighting

OIL BURNER.—Comprising a vaporizing apparatus partly filled with oil, and heated, and means for discharging compressed air against the oil vapors which pass through orifices for ignition. Patent 1622797. F. McCloskey, Box 562, Colorado Springs, Colo.

WATER HEATER.—In which the water circulates through an inner tube and backwardly through an outer tube, the latter being disposed at the hottest part of a combustion chamber. Patent 1625286. D. J. Shaffer, 286 Fox St., Aurora, Ill.

SIGN.—Particularly adapted for use on highways and at intersections of roads, mounted on a post and having a plurality of illuminated sides. Patent 1627437. A. H. Humphrey, Box 54, Salem, N. Y.

Machines and Mechanical Devices

VENDING MACHINE.—The arrangement being that a package is vended after each insertion of a coin, the coin shifting a locking mechanism as the device is rotated. Patent 1626429. J. Ruoff, c/o Hampton Novelty Co., 83 Worth St., New York, N. Y.

LUBRICATING APPARATUS.—Functioning as a grease cup, which may be entirely manual in its operation or semi-automatic. The device is simple in construction. Patent 1626478. W. R. E. Nohse, 144 E. 17th St., New York, N. Y.

COLLAPSING OIL DRILL.—For well drilling, which with its associated parts will drill a straight hole and effectively flush the hole with a hydraulic jet while drilling. Patent 1625247. B. J. and E. R. Dudley, 797 Highland Ave., Piedmont, Calif.

PORTABLE HONING OR LAPPING MACHINE.—Whereby the cylinders of any standard automobile engine may be expeditiously lapped without removal of the engine from the chassis. Patent 1624636. H. Strand, 1327 E. 112th St., Cleveland, Ohio.

THREAD TIGHTENER.—Adapted for use with buttonhole-sewing machines having automatic thread cutters in which the shears, after cutting, are swung sidewise out of the cloth pressure apparatus. Patent 1624898. A. Hennig, c/o Messrs. Fehlert, Loubier, Harmsen and Buttner, S. W. 61 Belle-Alliance-platz 17, Berlin, Germany.

CONCRETE, MORTAR AND PLASTER MIXER.—Including an oscillatory drum in which are provided staggered grate rods and vanes adjacent the walls, which will result in a stronger mixture with less manual effort. Patent 1624705. G. W. Adams, 807 Builders Exchange Bldg., San Antonio, Tex.

FOUR-CYLINDER DRAWHEAD. — For high draft with special weighting of the top rollers situate in front and behind the pair of drawing rollers. Patent 1624815. E. Toenniessen, c/o A. Elliot, 246 Friedrick Strasse, Berlin S. W. 48, Germany.

HOISTING-ENGINE CONTROL.—Which automatically shuts off the hoisting engine power and applies a brake mechanism when the skip or cage in a mine shaft exceeds a predetermined speed at either of its limits of travel, and an electrically actuated signal for informing the operator. The inventors have been granted two patents, 1624260 and 1624261. J. W. Lilly and H. H. Logan, c/o H. H. Logan, Duro Metal Products Co., 2649 N. Kildare Ave., Chicago, Ill.

TORCH MECHANISM FOR WELDING MACHINES.—Adapted to be introduced between two elements disposed in confronting relation, supported torch elements heating the confronting elements. Patent 1623503. C. L. Stancliff, 1005 Oregon St., East Bakersfield, Calif.

LAMINATED PACKING AND METHOD OF FORMING THE SAME.—As utilized in packing cups for pistons or plungers, avoiding the crinkling, stretching and ravelling of threads on the finished product. Patent 1625508. R. H. Thorne, Williamsport, Pa.

OIL WELL PUMP.—Which eliminates the possibility of sand settling upon and scoring the outer periphery of the stationary plunger, and provide an unobstructed discharge. Patent 1625230. C. B. Thurston, Box 222, Oildale, Calif.

VIENNA-ROLL-FORMING MACHINE.—Wherein means are provided for rapidly feeding dough to the forming device, forming the dough in desired manner, and then ejecting the prepared roll. Patent 1625649. C. Gottfried, 538 E. 72nd St., New York, N. Y.

LIQUID-MIXING APPARATUS.—For the general mixing of two liquids, but particularly for mixing milk of lime with sugar juices, in a raw sugar plant. Patent 1625592. E. T. Conant and L. S. McLane, Honomu, Territory of Hawaii.

BAILER DUMP.—For use in sinking deep oil wells, in which bailing and dumping operations may be optionally carried out by a device associated with the valve dart. Patent 1625686. S. A. Rutner, 84 Amsterdam Ave., New York, N. Y.

SAFETY FEED MEANS.—Which may be readily applied to washing machine wringers to cause an article to be fed to the rollers without injury to the hands. Patent 1627491. W. Doellnes, 743 Bergen Ave, Jersey City, N. J.

APPARATUS FOR VACUUMIZING *and* SEALING CANS.—The machine operates to puncture the sealed cover, withdraw the air from the can and seal the opening with solder, ready for shipment. Patent 1626291. A. E. Lindstrom, 17 Tehama St., San Francisco, Calif.

METHOD AND APPARATUS FOR MAKING COMPOSITE MOTION PICTURES.—By the use of a pair of objectives of different focus and a mirror or a miror silhouette. Patent 1627,295. E. Schufftan, Kaiser Alles 79a, Friedenan, Berlin, Germany.

PLUNGER PUMP.—Especially suitable for use in pumping chemical sprays for fruit trees, etc. Will stand heavy duty and continuous operation. Patent 162299. F. T. Costello, Box 487, Vacaville, Calif.

Prime Motors and Their Accessories

OIL REFINER FOR INTERNAL COMBUSTION ENGINES.—May be readily attached to a standard engine, and has means for heating the oil that it may more readily flow through the filter. Patent 1624957. C. E. Lilley, 5320 Brookside Blvd., Kansas City, Miss.

MOTOR.—Of the multi-cylinder type wherein the piston rods operate cams carried by oppositely disposed shafts, a rotary movement being imparted on the downward movement of the pistons. Patent 1624269. P. Marchetti, 735 Montgomery St., San Francisco, Calif.

MOTIVE-FLUID GENERATOR.—A heat generator and engine, both being so combined as to constitute an engine unit, resulting in a rigid economy of fuel. Patent 1624464. M. E. Bigelow, 1356 So. 6th E. St., Salt Lake City, Utah.

Medical and Surgical Devices

SURGICAL APPLIANCES.—Which will not only hold the tissues of a wound, but will tie a ligature on the tissue, the operation being performed with one hand. Patent 1625602. H. G. Gould and K. D. Obenshain, c/o H. G. Gould, McKinney, Tex.

OBSTETRICAL INSTRUMENT.—For use by veterinarians in facilitating the birth of animals, particularly pigs, insuring immediate delivery without danger, or injury, or undue suffering. Patent 1626149. E. O'Dell, Central City, Neb.

Musical Devices

REED HOLDER.—A comparatively stiff structure with flexible means for holding saxophone reeds against accidental injury by twisting or bending when carried in a pocket. Patent 1625651. F. Gretsch, c/o The Gretsch Mfg. Co., 60 Broadway, New York, N. Y.

Railroad and Their Accessories

RAILWAY-TRACK CONSTRUCTION.—Including means for supporting rails in special relation so that they are securely held against spreading, sinking or other movement, without the use of wooden ties. Patent 1625288. R. L. Spencer, Greenfield, Ark.

REVERSING GEAR FOR LOCOMOTIVES.—Adapted to be connected with the reach rod of a locomotive, and can be operated manually with ease, but prevents accidental retrograde movement. Patent 1625364. J. B. Holland, 923 Hollins St., Baltimore, Md.

RAILROAD SWITCH.—With means for facilitating the throwing of the switch points to either of their set positions and maintaining them firmly although yieldingly. Patent 1626752. B. H. Patrick, Box 82 Mount Gay, W. Va.

Pertaining to Recreation

RACKET STRING.—Formed by binding the strands of twisted gut with fine wire, preventing material swelling, and providing a wearing surface beyond the outer surface of the gut. Patent 1624720. A. M. Dritz, 258 5th Ave., New York, N. Y.

TARGET GAME.—An apparatus having a figure simulating a baseball player with a bat, the bat carrying target elements which are to be struck by thrown balls. Patent 1624765. W. C. Schmeh, Main St., Park Ridge, N. J.

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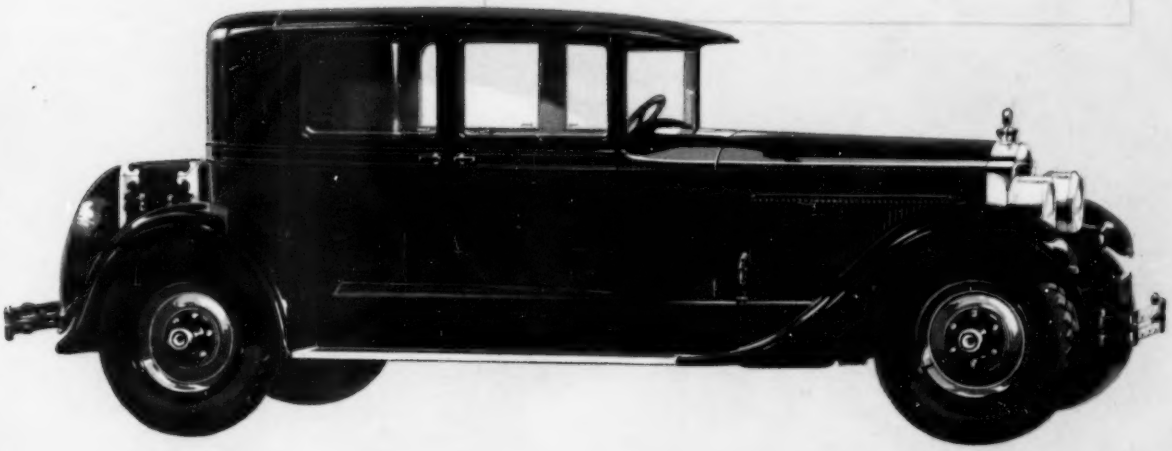

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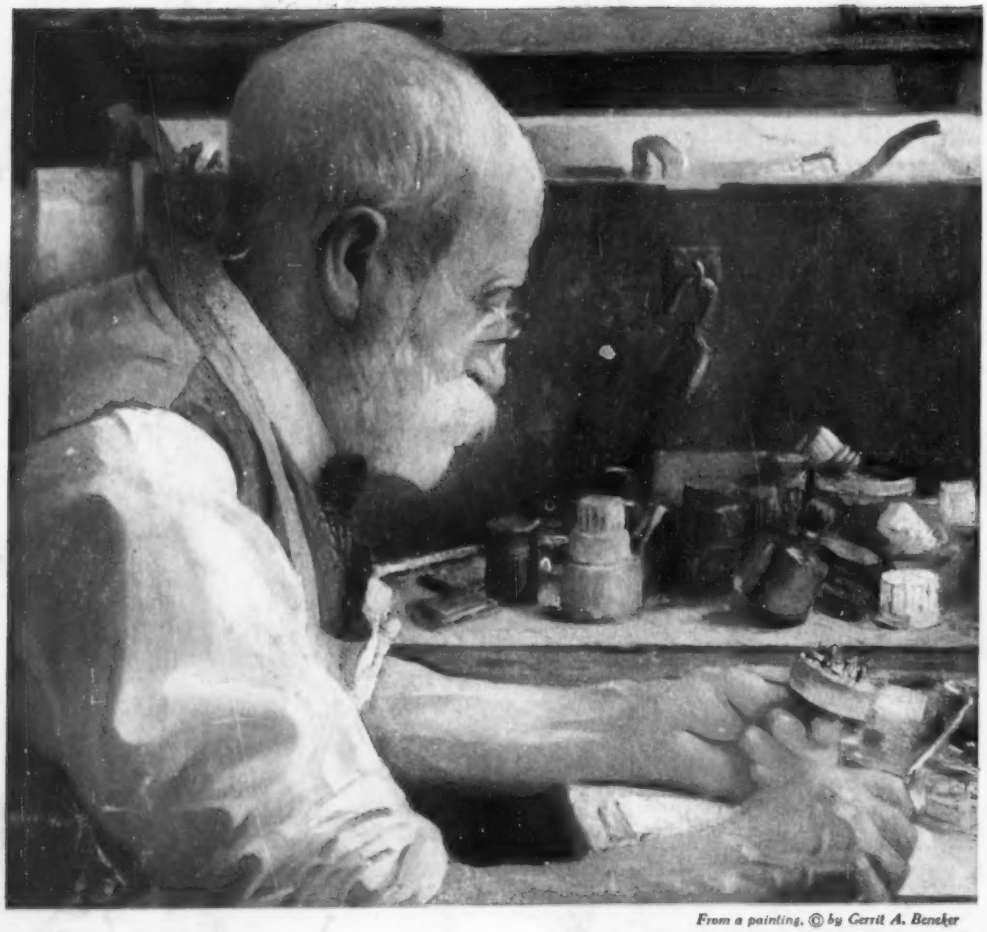

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